4.17.5 Cost of the No Action Alternative

The No Action Alternative has an estimated undiscounted cost, exceeding $1.1 billion, of which $210 million is attributable to common facilities and equipment, $10 million is attributable to ongoing R&D, $446 million is attributable to individual processing technologies, and $460 million is attributable to storing stabilized residues and transuranic waste on site for twenty years. Disposal costs at WIPP are estimated at $3 million. No indirect costs are charged for deferring the return of the site to alternative uses.

4.17.6 Cost of the Minimum Duration Management Approach

Costs for the Minimum Duration Management Approach are presented in **Table 4-64.** Decisional costs are roughly midway between those of the Preferred Alternative and the Minimum Cost Management Approach. As compared to the Preferred Alternative, the Minimum Duration Alternative repackages the sand, slag, and crucible under Alternative 4, scrubs the other electrorefining and molten salt extraction salts for Purex processing at the Savannah River Site, pyro-oxidizes all the direct oxide reduction salts for processing at the Los Alamos National Laboratory, blends down all the combustibles and sludges, and vitrifies all of the high efficiency particulate filters and glass.

Table 4–64 Costs of the Minimum Duration Management Approach

Material Category	*Processing Technology*	*Approximate Cost, ($M)*	*Processing Time[a] Saved at Rocky Flats versus the Preferred Processing Technology*
Incinerator Ash	Repackage at Rocky Flats under Alternative 4	58	--
Sand, Slag, and Crucible	Repackage at Rocky Flats under Alternative 4	11	3 months
Graphite Fines	Repackage at Rocky Flats under Alternative 4	4	--
Inorganic Ash	Repackage at Rocky Flats under Alternative 4	8	--
Molten Salt Extraction and Electrorefining Salts IDC 409	Pyro-oxidize, blend and repackage at Rocky Flats under Alternative 4	19	--
Other Electrorefining and Molten Salt Extraction Salts	Salt Scrub at Rocky Flats, Purex Process at the Savannah River Site F-Canyon	86[b]	1.5 years
Direct Oxide Reduction Salts, IDCs 365, 413, 427	Pyro-Oxidize at Rocky Flats, Acid Dissolve at Los Alamos National Laboratory	17[b]	--
Other Direct Oxide Reduction Salts	Pyro-Oxidize at Rocky Flats, Acid Dissolve at Los Alamos National Laboratory	19[b]	4 months
Aqueous-contaminated Combustibles	Blend Down at Rocky Flats	2	2 months
Organic-contaminated Combustibles	Blend Down at Rocky Flats	1	5 months
Dry Combustibles	Blend Down at Rocky Flats	1	negligible
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	18	--
Ful Flo Filter Media	Blend Down at Rocky Flats	4	--
HEPA IDC 338 Filter Media	Vitrify at Rocky Flats	11	1 year
Other HEPA Filter Media	Vitrify at Rocky Flats	1	negligible
Sludge (IDC 089, 099, 332)	Blend Down and repackage at Rocky Flats under Alternative 4	1	--

Material Category	***Processing Technology***	***Approximate Cost, ($M)***	***Processing Time[a] Saved at Rocky Flats versus the Preferred Processing Technology***
Other Sludge	Blend Down at Rocky Flats	3	2 months
Glass	Vitrify at Rocky Flats	1	negligible
Graphite	Repackage at Rocky Flats at Rocky Flats under Alternative 4	8	--
Inorganic	Repackage at Rocky Flats at Rocky Flats under Alternative 4	2	--
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F-Canyon	20	--
Total Individual Costs[b,c,d]		~292	--
Of Which, Materials Disposition Costs[d]		~40	--
Plus Shared Equipment Costs[d]		0[b]	---
Subtotal - Decisional Costs[b,d]		~292	--
Common Facilities Costs at Rocky Flats[e]		~180	--
R&D Costs at Rocky Flats and Los Alamos National Laboratory[e]		~10	--
Total		~482	not additive

[a] Processing times are not additive because the facilities' schedules are not optimized.
[b] Program costs depend on whether the Savannah River Site uses F Canyon or H Canyon for Purex processing and whether the Los Alamos National Laboratory uses acid dissolution or water leach for the direct oxide reduction salts. Processing times at Rocky Flats are unaffected.
[c] Because costs for many of the minor residues are significantly less than $1 million but are shown as $1 million, the sum of the individual costs on the table exceeds the actual total.
[d] Costs that DOE would incur by selecting the specified processing technologies.
[e] Costs that DOE expects to incur regardless of the processing technologies selected

The result is a duration at Rocky Flats estimated at 2.6 years, with the longest duration at Building 707, Module E. This duration is the non-optimized sum of the durations of the shortest individual processing technologies for each material category. All tables in this EIS showing summed durations use the non-optimized sum of the shortest individual processing technologies.

4.17.7 Technical Uncertainties

Table 4-65 shows the processing technologies for the major residue categories according to their technical uncertainty. (Schedule uncertainties are summarized in Appendix G.) The low-uncertainty processing technologies are nearly free of technical uncertainty. The moderate-uncertainty processing technologies are riskier than the low-uncertainty processing technologies. The high-uncertainty processing technologies are at the boundary of technical acceptability and would carry very substantial costs if they were implemented and subsequently fail.

Table 4–65 Technical Uncertainties for Major Categories of Processing Technologies

Residue	***Low Uncertainty***	***Moderate Uncertainty***	***High Uncertainty***
Ash	Blend down, Purex Process at the Savannah River Site, Repackage (excluding sand, slag, and crucible)	Vitrification, Mediated Electrochemical Oxidation at the Savannah River Site, Calcine and Cement, Cement, Cold Ceramification	Repackage (sand, slag and crucible only)
Salt	Pyro-oxidation, Blend down (low mass/low assay granules), Acid Dissolution, Purex Process at the Savannah River Site, Repackage	Salt Scrub in preparation for Purex Process at the Savannah River Site	Distillation, Water Leach, Blend down (high mass/high assay chunks)
Combustibles	Neutralize/Dry, Repackage (dry only)	Mediated Electrochemical Oxidation, Sonic Wash, Thermal Desorption, Catalytic Chemical Oxidation	Blend down (nitric acid- and organic-contaminated residues)
Fluoride	Blend down (low mass/low assay granules), Purex Process at the Savannah River Site	Acid Dissolution	Blend down (high mass/high assay chunks)
Filter Media	Neutralize/Dry, Repackage (other HEPA filters only)	Vitrification, Mediated Electrochemical Oxidation, Sonic Wash	Blend down (nitric acid-contaminated residues)
Sludge	Blend down, Filter/Dry Repackage (IDC 089, 099, 332 only)	Sonic Wash, Acid Dissolution	Vitrification
Glass	Blend down, Neutralize/Dry	Vitrification, Mediated Electrochemical Oxidation	--
Graphite	Blend down, Repackage	Vitrification, Mediated Electrochemical Oxidation at the Savannah River Site, Cement	--
Inorganics	Blend down, Repackage	Vitrification, Mediated Electrochemical Oxidation, Mediated Electrochemical Oxidation at the Savannah River Site, Sonic Wash	--
Scrub Alloy	Purex Process at the Savannah River Site, Repackage	Calcine and Vitrify	--

Among the major residue categories, distillation of molten salt extraction salt residues at the Los Alamos National Laboratory carries the highest technical and economic uncertainties. Salt distillation in general is unproven at the scale proposed for the residues in this program. If new distillation equipment and related upgrades are required at the Los Alamos National Laboratory for the IDC 409 electrorefining and molten salt extraction salts, equipment costs could be as high as $37 million. Distillation of electrorefining and molten salt extraction salts (excluding IDC 409 salts) at the Los Alamos National Laboratory would require $115 million in capital expenditures for distillation equipment, facilities upgrades, and vault upgrades over a 6-8 year period. The americium-plutonium output from the distillation process would be packaged in 3013 containers and retained at the Los Alamos National Laboratory pending approval in the present EIS or related EISs (e.g., disposition of fissile materials) to ship the plutonium to the Savannah River Site.

In the case of the IDC 409 molten salt extraction salts and the IDCs 365, 413, and 427 direct oxide reduction salts, blending prior to repackaging in the preferred alternative is required. Although blending and repackaging is a low uncertainty processing technology overall, some individual cans of salts may have chunks of high assay, high mass materials that cannot be blended down without new and/or unproven technologies and equipment. For these salt chunks, some form of separation is preferred. In the case of the direct oxide reduction salts, especially but not exclusively the high assay IDC 365, 413, and 427 categories, the incremental cost of acid dissolution at the Los Alamos National Laboratory would be about $17 million more than repackaging under Alternative 4. Costs for water leaching the direct oxide reduction salts are similar but technical risks are higher. Pyro-oxidation of direct oxide reduction salts as a precursor to acid dissolution (not pyro-oxidation as a stand-alone process) is unproven using the existing technologies at Rocky Flats.

Alternatively, the salts could be scrubbed at Rocky Flats for Purex processing at the Savannah River Site. Although salt scrub is a low-uncertainty process in general, scrubbing of less pure salts or salts that have absorbed moisture during storage creates moderate to high technical uncertainties, including worker exposure. A small but non-trivial portion of the salts at Rocky Flats is likely to be in these categories. Development work on scrubbing off-specification salts would be required prior to or in parallel with the scrubbing operations. Finally, if the salts are pyro-oxidized in preparation for distillation, the Purex processing technology at Savannah River Site would be foreclosed.

Repackaging sand, slag, and crucible under Alternative 4 carries high technical uncertainties due to the potential for reactivity and pyrophoricity. Before sand, slag, and crucible could be certified for disposal at WIPP under this processing technology, Rocky Flats would have to conduct characterization activities well beyond the levels required for ordinary transuranic waste. The cost and duration of this characterization is uncertain but it would be a minimum of several months and several million dollars. If processing technologies for sand, slag, and crucible are deferred while the characterizations required for repackaging under Alternative 4 take place and repackaging is ultimately rejected, processing, shipping, and scheduling windows at Rocky Flats and the Savannah River Site would be adversely affected.

Ash vitrification is among the more uncertain of the moderate uncertainty technologies. The proposed approach to ash vitrification includes a calcination stage ahead of the vitrification stage. This increases the cost of vitrification, but reduces the uncertainty. Optimization studies are underway to determine if calcination can be bypassed without affecting the acceptability of the waste form.

Blending or vitrifying combustibles, filter media, and sludges carry various technical and schedule uncertainties as outlined in Section 4.17.4.

4.18 SOCIOECONOMICS

The socioeconomic impacts from the management of Rocky Flats' plutonium residues and scrub alloy depend on the management approach selected to manage all the materials. Socioeconomic impacts can only be estimated for management approaches rather than for individual technologies. In general, the processing technologies that require the most labor and generate the most transuranic waste generate the greatest socioeconomic impact.

Table 4-66 shows estimated allocable costs at Rocky Flats for materials and waste processing. The following points are important in interpreting the table:

- Expenditures on facilities upgrades and technology development (discussed in 4.17.1) are excluded from the table since these expenditures will be incurred independent of decisions in the present EIS.
- Expenditures relating to waste packages, shipping, disposal at WIPP, fissile materials disposition, and other off-site activities are excluded from the table since they do not create socioeconomic impacts at Rocky Flats.
- Annualized site spending, including allocations of existing and ongoing site overheads are in the range of $50-60 million for all management approaches except for the No Action Alternative.

- Annualized costs for the processing technologies are $20-40 million, with two or three processing technologies carried out concurrently. Most processing technologies require only a small fraction of a year to complete. Processing technologies for ash and salt residues, which may take several years, determine most of the impacts.

- The costs in the processing column include an allocation of fixed and semi-fixed site costs (e.g., security, administration, materials management) that will not be appreciably affected by the management of the plutonium residues but are allocable to the program.

- Socioeconomic impacts from management approaches other than the No Action Alternative are compared to the impacts from the No Action Alternative, not to a zero expenditure baseline. To the extent the expenditure profile in a management approach is similar to the expenditure profile for the No Action Alternative, the socioeconomic impacts from that management approach are similar.

Table 4–66 Estimated Spending at Rocky Flats by Activity for Each Processing Technology (excluding common facilities, technology development, and shared equipment)

		Years	*Processing $M*	*Transuranic Waste $M*	*Low-Level Waste$M*	*Total $M*	*Total $M/yr*
Incinerator Ash	Calcine & Cement at Rocky Flats	3.6	110	38	2	150	41.3
Incinerator Ash	Vitrification at Rocky Flats	1.9	34	36	1	72	37.7
Incinerator Ash	Cold Ceramification at Rocky Flats	1.9	34	36	1	71	37.7
Incinerator Ash	Blend Down at Rocky Flats	2.5	52	43	1	95	38.3
Incinerator Ash	Fusion at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.5	8	4	1	13	27.2
Incinerator Ash	Fusion at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.5	8	4	1	13	27.2
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F Canyon	0.4	6	4	1	11	28.0
Incinerator Ash	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H Canyon	0.4	6	4	1	11	28.0
Incinerator Ash	Calcine & Cement at Rocky Flats (Alternative 4)	3.6	110	38	2	150	41.3
Incinerator Ash	Repackage at Rocky Flats (Alternative 4)	1.3	4	37	1	42	33.5
Sand, slag & crucible	Calcine & Cement at Rocky Flats	0.6	16	8	0	24	40.1
Sand, slag & crucible	Vitrification at Rocky Flats	0.4	5	8	0	13	36.5
Sand, slag & crucible	Blend Down at Rocky Flats	0.5	7	9	0	17	37.0
Sand, slag & crucible	Repackage at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.1	1	1	0	2	22.8
Sand, slag & crucible	Repackage at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.1	1	1	0	2	22.8
Sand, slag & crucible	Calcine & Cement at Rocky Flats (Alternative 4)	0.5	16	2	0	18	40.1
Sand, slag & crucible	Repackage at Rocky Flats (Alternative 4)	0.2	1	7	0	8	34.2
Graphite Fines	Cement at Rocky Flats	0.2	7	2	0	10	41.3
Graphite Fines	Vitrification at Rocky Flats	0.1	3	2	0	5	38.4
Graphite Fines	Blend Down at Rocky Flats	0.2	3	3	0	6	38.5
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F Canyon	0.0	0	0	0	1	27.4
Graphite Fines	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H Canyon	0.0	0	0	0	1	27.4
Graphite Fines	Cement at Rocky Flats (Alternative 4)	0.2	7	2	0	10	41.3

		Years	***Processing $M***	***Transuranic Waste $M***	***Low-Level Waste$M***	***Total $M***	***Total $M/yr***
Graphite Fines	Repackage at Rocky Flats (Alternative 4)	0.1	0	2	0	3	33.8
Inorganic Ash	Calcine & Cement at Rocky Flats	0.3	6	5	0	12	38.6
Inorganic Ash	Vitrification at Rocky Flats	0.2	2	5	0	7	35.2
Inorganic Ash	Blend Down at Rocky Flats	0.3	3	6	0	9	35.6
Inorganic Ash	Calcine & Cement at Rocky Flats (Alternative 4)	0.3	6	5	0	12	38.6
Inorganic Ash	Repackage at Rocky Flats (Alternative 4)	0.2	0	5	0	6	32.9
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats	0.6	12	10	0	22	38.1
MSE/ER Salts (IDC 409)	Blend Down at Rocky Flats	1.0	30	10	0	40	41.2
MSE/ER Salts (IDC 409)	Distillation at Rocky Flats	0.2	7	1	0	8	40.3
MSE/ER Salts (IDC 409)	Water Leach at Rocky Flats	1.0	27	11	3	40	41.6
MSE/ER Salts (IDC 409)	Pyro-oxidize at Rocky Flats and Distillation at Los Alamos National Laboratory	0.1	5	1	0	6	42.5
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.2	6	1	0	8	42.0
MSE/ER Salts (IDC 409)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.2	6	1	0	8	42.0
MSE/ER Salts (IDC 409)	Pyro-oxidize, Blend, and Repackage at Rocky Flats (Alternative 4)	0.4	8	10	0	18	42.3
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats	1.5	28	29	1	57	37.8
MSE/ER Salts (All Others)	Blend Down at Rocky Flats	3.9	73	72	1	146	37.6
MSE/ER Salts (All Others)	Distillation at Rocky Flats	0.5	18	3	1	22	40.1
MSE/ER Salts (All Others)	Water Leach at Rocky Flats	4.1	65	80	19	164	39.9
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats and Distillation at Los Alamos National Laboratory	0.4	13	3	1	17	42.0
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.6	16	8	1	24	41.4
MSE/ER Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.6	16	8	1	24	41.4
MSE/ER Salts (All Others)	Pyro-oxidize at Rocky Flats (Alternative 4)	1.5	27	29	1	56	37.7
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats	0.4	12	4	0	16	41.0
DOR Salts (IDCs 365, 413, 427)	Blend Down at Rocky Flats	0.5	18	5	0	22	41.7

		Years	*Processing $M*	*Transuranic Waste $M*	*Low-Level Waste$M*	*Total $M*	*Total $M/yr*
DOR Salts (IDCs 365, 413, 427)	Water Leach at Rocky Flats	0.5	16	5	1	23	42.0
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	0.0	1	0	0	1	42.5
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	0.0	1	0	0	1	42.5
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.1	4	1	0	4	41.9
DOR Salts (IDCs 365, 413, 427)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.1	4	1	0	4	41.9
DOR Salts (IDCs 365, 413, 427)	Pyro-oxidize, Blend, and Repackage at Rocky Flats (Alternative 4)	0.3	4	6	0	10	36.8
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats	0.2	4	2	0	7	39.9
DOR Salts (All Others)	Blend Down at Rocky Flats	0.4	5	9	0	14	35.7
DOR Salts (All Others)	Water Leach at Rocky Flats	0.5	6	10	2	19	39.5
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Acid Dissolution at Los Alamos National Laboratory	0.0	0	0	0	1	40.3
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats and Water Leach at Los Alamos National Laboratory	0.0	0	0	0	1	40.3
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.1	1	1	0	2	40.5
DOR Salts (All Others)	Salt Scrub at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.1	1	1	0	2	40.5
DOR Salts (All Others)	Pyro-oxidize at Rocky Flats (Alternative 4)	0.2	4	2	0	7	39.9
Aqueous-Contaminated Combustibles	Neutralize/Dry at Rocky Flats	0.1	2	3	0	5	41.7
Aqueous-Contaminated Combustibles	Sonic Wash at Rocky Flats	0.1	2	1	0	3	39.7
Aqueous-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	0.3	7	4	1	12	41.2
Aqueous-Contaminated Combustibles	Blend Down at Rocky Flats	0.0	1	1	0	1	38.0
Aqueous-Contaminated Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	0.2	2	4	1	6	38.7

		Years	Processing $M	Transuranic Waste $M	Low-Level Waste$M	Total $M	Total $M/yr
Aqueous-Contaminated Combustibles	Neutralize/Dry at Rocky Flats at Rocky Flats(Alternative 4)	0.1	2	3	0	5	41.7
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation at Rocky Flats	0.1	3	2	0	5	43.2
Organic-Contaminated Combustibles	Sonic Wash at Rocky Flats	0.1	2	1	0	2	40.0
Organic-Contaminated Combustibles	Catalytic Chemical Oxidation at Rocky Flats	0.2	5	3	0	8	42.8
Organic-Contaminated Combustibles	Blend Down at Rocky Flats	0.0	0	0	0	1	38.8
Organic-Contaminated Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	0.1	1	3	0	4	41.3
Organic-Contaminated Combustibles	Thermal Desorption / Steam Passivation at Rocky Flats	0.1	3	2	0	5	43.2
Dry Combustibles	Repackage at Rocky Flats	0.0	0	2	0	2	40.3
Dry Combustibles	Sonic Wash at Rocky Flats	0.1	1	1	0	2	39.7
Dry Combustibles	Catalytic Chemical Oxidation at Rocky Flats	0.2	4	2	1	7	41.2
Dry Combustibles	Blend Down at Rocky Flats	0.0	0	0	0	1	38.0
Dry Combustibles	Mediated Electrochemical Oxidation at Rocky Flats	0.1	1	2	1	4	38.8
Dry Combustibles	Repackage at Rocky Flats (Alternative 4)	0.0	0	2	0	2	40.3
Plutonium Fluorides	Acid Dissolution at Rocky Flats	0.4	13	3	1	17	43.5
Plutonium Fluorides	Blend Down at Rocky Flats	1.3	23	26	0	50	37.1
Plutonium Fluorides	Acid Dissolution at Rocky Flats	0.4	13	2	1	16	42.4
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.0	0	0	0	1	26.3
Plutonium Fluorides	Repackage at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.0	0	0	0	1	26.3
Ful Flo Filter Media	Neutralize/Dry at Rocky Flats	0.3	3	11	0	13	41.3
Ful Flo Filter Media	Blend Down at Rocky Flats	0.1	1	2	0	3	36.8
Ful Flo Filter Media	Sonic Wash at Rocky Flats	0.1	2	2	0	5	38.2
Ful Flo Filter Media	Mediated Electrochemical Oxidation at Rocky Flats	0.2	2	6	1	9	38.8
HEPA Filters (IDC 338)	Neutralize/Dry at Rocky Flats	0.8	13	23	0	35	42.0
HEPA Filters (IDC 338)	Vitrification at Rocky Flats	0.2	4	4	0	9	38.0

		Years	*Processing $M*	*Transuranic Waste $M*	*Low-Level Waste$M*	*Total $M*	*Total $M/yr*
HEPA Filters (IDC 338)	Blend Down at Rocky Flats	0.2	5	4	0	9	38.9
HEPA Filters (IDC 338)	Sonic Wash at Rocky Flats	0.4	11	5	0	16	40.5
HEPA Filters (IDC 338)	Mediated Electrochemical Oxidation at Rocky Flats	0.6	8	12	3	23	39.6
HEPA Filters (IDC 338)	Neutralize/Dry at Rocky Flats (Alternative 4)	0.8	13	23	0	35	42.0
HEPA Filters (All Others)	Neutralize/Dry at Rocky Flats	0.0	0	1	0	1	41.5
HEPA Filters (All Others)	Vitrification at Rocky Flats	0.0	0	0	0	0	35.2
HEPA Filters (All Others)	Blend Down at Rocky Flats	0.0	0	0	0	1	39.2
HEPA Filters (All Others)	Sonic Wash at Rocky Flats	0.0	0	0	0	1	37.0
HEPA Filters (All Others)	Mediated Electrochemical Oxidation at Rocky Flats	0.0	0	1	0	1	38.5
HEPA Filters (All Others)	Blend and Repackage at Rocky Flats (Alternative 4)	0.0	0	1	0	1	41.5
Sludge (IDCs 089, 099, 332)	Filter/Dry at Rocky Flats	0.0	0	0	0	0	41.5
Sludge (IDCs 089, 099, 332)	Vitrification at Rocky Flats	0.0	0	0	0	0	40.9
Sludge (IDCs 089, 099, 332)	Blend Down at Rocky Flats	0.0	0	0	0	0	38.2
Sludge (IDCs 089, 099, 332)	Blend and Repackage at Rocky Flats (Alternative 4)	0.0	0	0	0	0	37.5
Sludge (All Others)	Filter/Dry at Rocky Flats	0.3	3	8	0	11	41.6
Sludge (All Others)	Vitrification at Rocky Flats	0.1	1	1	0	3	37.8
Sludge (All Others)	Blend Down at Rocky Flats	0.1	1	1	0	3	37.8
Sludge (All Others)	Acid Dissolution at Rocky Flats	0.5	14	4	1	19	42.7
Sludge (All Others)	Filter/Dry at Rocky Flats (Alternative 4)	0.3	3	8	0	11	41.6
Glass	Neutralize/Dry at Rocky Flats	0.0	0	0	0	0	41.6
Glass	Vitrification at Rocky Flats	0.0	0	0	0	0	37.5
Glass	Blend Down at Rocky Flats	0.0	0	0	0	1	37.9
Glass	Sonic Wash at Rocky Flats	0.0	1	0	0	1	39.9
Glass	Mediated Electrochemical Oxidation at Rocky Flats	0.0	0	1	0	2	39.2
Glass	Neutralize/Dry at Rocky Flats(Alternative 4)	0.0	0	0	0	0	41.6
Graphite	Repackage at Rocky Flats	0.2	1	5	0	6	34.8
Graphite	Cement at Rocky Flats	0.2	2	5	0	8	36.1
Graphite	Vitrification at Rocky Flats	0.2	4	4	0	8	37.5
Graphite	Blend Down at Rocky Flats	0.2	4	4	0	8	37.4
Graphite	Mediated Electrochemical Oxidation at Rocky Flats	0.6	8	14	3	25	39.5

		Years	Processing $M	Transuranic Waste $M	Low-Level Waste$M	Total $M	Total $M/yr
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F Canyon	0.1	1	1	0	1	25.1
Graphite	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H Canyon	0.1	1	1	0	1	25.1
Graphite	Repackage at Rocky Flats (Alternative 4)	0.2	1	5	0	6	34.8
Inorganics	Repackage at Rocky Flats	0.0	0	1	0	1	34.9
Inorganics	Vitrification at Rocky Flats	0.0	1	1	0	2	37.5
Inorganics	Blend Down at Rocky Flats	0.0	1	1	0	2	38.1
Inorganics	Mediated Electrochemical Oxidation at Rocky Flats	0.1	2	3	1	6	39.3
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site F Canyon	0.0	0	0	0	0	22.3
Inorganics	Repackage at Rocky Flats and Mediated Electrochemical Oxidation at the Savannah River Site H Canyon	0.0	0	0	0	0	22.3
Inorganics	Repackage at Rocky Flats (Alternative 4)	0.0	0	1	0	1	34.9
Scrub Alloy	Repackage at Rocky Flats	0.1	0	2	0	3	40.5
Scrub Alloy	Calcine and Vitrification at Rocky Flats	1.5	41	19	0	60	40.1
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site F Canyon	0.0	0	0	0	1	27.2
Scrub Alloy	Repackage at Rocky Flats and Purex Process at the Savannah River Site H Canyon	0.0	0	0	0	1	27.2

4.18.1 The No Action Alternative at Rocky Flats

In the No Action Alternative, direct and indirect labor and waste-related spending at Rocky Flats is estimated at about $399 million. Of this sum, about $239 million is related to labor (including site overheads) and low-level waste processing. It would be incurred over a weighted average of about 6.2 years of processing, with a maximum duration at any single facility of 7.2 years.[1] The remaining $160 million is related to packaging and characterization of the stabilized residues and transuranic waste. It would be incurred over an unspecified period of years, with the minority of expenditures (e.g., packaging) taking place concurrent with processing and the majority of the expenditures (i.e., characterization) probably taking place towards the end of the interim storage period (i.e., 2010-2015). Interim storage would also generate an estimated $23 million per year in incremental costs to maintain the site to store the stabilized residues and transuranic waste. This post-closure expenditure for storage is purely incremental to DOE budgets and site spending. Although DOE has not developed schedules or spending profiles for these post-2006 programs at the otherwise shut-down site, the following inferences can be made:

- During the period of No Action processing (about 1998-2005), the incremental spending at Rocky Flats for processing and low-level waste management is likely to exceed existing site spending by no more than $10-15 million per year. Of the roughly $40 million per year in average allocable expenditures at the site for activities other than transuranic waste management ($239 million over six years), very roughly 2/3 would be attributable to expenditures and staffing at the site that would be the same (or similar) with or without the No Action processing activities. The discussion in Section 4.17.2 on labor multipliers addresses this issue.

- During the period of interim storage (about 2006-2015), the incremental spending at Rocky Flats for site maintenance and transuranic waste characterization and management would require incremental spending of as much as $40-45 million per year. This spending would consist of about $23 million per year for maintaining the otherwise shutdown site and about $15-20 million per year for characterization of the stabilized residues and transuranic waste for the eventual shipment offsite. For cost analysis, this offsite shipment is assumed to be to WIPP by 2015.

- Incremental spending of $15-20 million per year could be accelerated to the processing period (1998-2005) from the interim storage period if characterization of the stabilized residues were conducted during processing and packaging rather than during interim storage.

In terms of labor requirements at the site, the processing activities under the No Action Alternative may require a few hundred people for six or seven years. Characterization activities could also require 100-200 people over either the processing period or the interim storage period. It is uncertain how many of these employees would be net additions to the site staff since detailed budgets and program plans for No Action processing and deferred characterization have not been developed. It is likely that a mix of existing and new employees will be used and that incremental labor requirements could be in the range of a few hundred over the 6-7 year period. During the interim storage period, an additional few hundred people currently maintaining and operating the site would be retained for up to about nine years. These numbers compare to current site employment exceeding 5,000.[2]

---

1 Processing durations of 5.5 years at Building 707, Module A, 6.0 years at Building 707, Module E, and Building 371, Room 3701. Durations at other facilities are minor.

2 Many large-scale activities are underway at Rocky Flats that have no bearing on the present EIS, for example, management and disposition of highly enriched uranium and plutonium solutions. It would thus be improper for the present EIS to discuss site activities, especially site closure, as if it were entirely a function of the completion

(continued...)

Potentially significant impacts could be generated in two ways: (1) the interim storage period and the deferred conduct of characterization activities would preserve site employment at a level of several hundred for up to nine years beyond the date when the site would otherwise be closed (2006), and (2) the interim storage period would prevent DOE from returning the site (or some large portion of the site) to alternative productive uses for the same nine years. The former effect would be to continue injecting $40-45 million or more into the local economy for up to nine years after the planned closure of the site. The latter effect would be to lose some unspecified value from failing to promptly return the site to alternative productive uses.

In the context of the Denver metropolitan area, the multiplied effect of these expenditures during the processing period would appear as a modest increase in employment and income over existing site operations. Incremental multiplied regional employment during the processing period would be as much as 400-500 people. Incremental multiplied regional income during the processing period could be as much as $40 million per year. During the interim storage period, the first effect of the No Action Alternative would be to preserve employment and income in the area at a higher level than at a shutdown site. Compared to a closed site, incremental multiplied employment and income could be as much as 750-1,000 people and incremental multiplied income could be $80-100 million. As a practical matter, these gains would appear as a continuation of site activity rather than as a new phase in site activity. On the other hand, deferring the return of the site to alternative productive uses could generate higher negative socioeconomic consequences than continuing to maintain the site for interim storage and transuranic characterization.

4.18.2 Other Management Approaches at Rocky Flats

Table 4-67 shows the estimated spending at the site for the eight strategic management approaches (excluding costs for (1) common facilities upgrades and technology development, neither of which is decisional in this EIS, and (2) itemized, shared equipment, which is decisional).[3] The table shows that compared to the No Action alternative (excluding costs for maintaining the stabilized residues onsite beyond 2006), the other strategic management approaches generate much less total spending at Rocky Flats. The following points are significant:

- The No Action processing technologies for ash residues are $100-200 million more expensive than any of the processing technologies in the other management approaches. The difference in ash processing alone explains most of the difference in costs and durations for the No Action Alternative and the other management approaches.

- The No Action Alternative is assumed to require transuranic waste characterization expenditures during the interim storage period. The other management approaches are assumed to require transuranic waste characterization expenditures during the processing period. This difference explains the higher cost per year between the No Action Alternative on the one hand and the other management approaches on the other hand.

---

2 (...continued)
of the residues management in the present EIS. It is material in a socioeconomic context to note that if the preferred alternative in the present EIS is selected in the Record of Decision, management of the plutonium residues and scrub alloy is not on the critical path for closure of the facility.

3 The only strategic management approach for which including itemized, shared equipment would make a major difference in expenditures at Rocky Flats is the Maximum Plutonium Separation Management Approach. Mediated electrochemical oxidation equipment requires an expenditure of $30 million, a portion of which would take place in the region of influence. Several processing technologies require an expenditure of $4 million at Rocky Flats for distillation equipment. This expenditure has no socioeconomic significance. These issues are discussed in Section 4.17.1.

Table 4–67 Estimated Spending at Rocky Flats for the Strategic Management Approaches

	No Action	*Preferred*	*Minimum Time at Rocky Flats*	*Lowest Cost*	*All at Rocky Flats*	*Fewest at Rocky Flats*	*Maximum Plutonium Separation*	*No Plutonium Separation*
[illegible]	309 plus 207 for deferring closure	207	130	127	208	106	123	286
[illegible]	6.2	3.9	1.6	2.2	3.1	2.0	2.7	4.7
[illegible] (years)	7.2	5.5	2.6	3.2	5.1	2.8	3.4	10.2

- The more material is shipped to the Savannah River Site or the Los Alamos National Laboratory for processing (e.g., Fewest Actions at Rocky Flats) the briefer the spending profile at Rocky Flats. The average spending per year is relatively fixed but the durations change.

- The greater the difference between the average site-wide processing duration and the maximum single facility duration, the lower the annual expenditures and the more diffuse the spending pattern. This is significant only in the No Plutonium Separation Management Alternative. Average spending is in the $50-60 million per year range in general.

From a socioeconomic perspective, the other management approaches differ from each other only in duration. Once a management approach is completed, spending declines markedly. This decline relates both to the completion of processing activities and (depending on activities outside the present EIS) the winding down of overall site activities. The net result, compared to the No Action Alternative, is the withdrawal from the local economy of several hundred direct jobs and a like number of indirect jobs starting after a few years and about two to three times the reduction in employment a few years after that. The multiplied reduction in income would be as much as $50 million after a few years and well over $100 million per year once closure of the site was underway. These values are in the range of 1/4 of one percent to 1/2 of one percent or more of the $20 billion annual economy of the region. Employment impacts in the over-2 million regional labor force is a slightly smaller percentage due to the high average labor compensation at the site. In the long-run, the potential gains to the region from a prompt return of the site or most of the site to alternative productive uses should more than offset the short-term income and employment losses.

4.18.3 Savannah River Site

The preferred management approach includes Purex processing at F-Canyon of sand, slag, and crucible residues, fluorides residues, and scrub alloy. Collectively, these materials would increase spending at the Savannah River Site by perhaps $15 million per year compared to the No Action Alternative. If the materials were processed at the Savannah River Site H-Canyon, spending would increase by about twice as much. If all the materials that could be shipped to the Savannah River Site were shipped there in the maximum labor cost configuration for the Savannah River Site, the incremental labor allocable to the Savannah River Site would be about $30 million per year over a longer period. The majority of these costs would be incurred for processing ash and salts. Costs for Purex processing at H-Canyon would be extended for several years longer.

Costs for mediated electrochemical oxidation at H-Canyon would be $20 million higher than at F-Canyon for a 2-year decontamination and decommissioning phase and then would be similar.

The addition of an incremental $15 million per year for some number of years, although not large, would be noticeable in the Savannah River Site regional economic area. The Savannah River Site accounts for about 7 percent of regional economic area employment, versus 3/10 of 1 percent for Rocky Flats. Assuming all of the incremental hires at the Savannah River Site were recruited from currently unemployed people in the 15-county regional economic area, the unemployment rate would decline by more than 1/10 of 1 percentage point. Income in the six-county region of influence would increase by more than 1/10 of 1 percent for each of the years in which the processing activities took place. The site, the regional economic area, and the region of influence could easily accommodate all of these income-related benefits since the increase would be only a small percentage of the reductions in jobs and income experienced in the area due to reductions in site staffing in the 1990s. The net effect would be one of restoring some of the economic and socioeconomic benefits associated with the site rather than adding new benefits in an otherwise stable area.

The one potentially important variation on the Savannah River Site impacts would be if shipments of Rocky Flats plutonium residues and scrub alloy were responsible for extending the operations at one of the canyons. This EIS assumes that the Rocky Flats plutonium residues and scrub alloy can be processed incrementally with other materials that make up the baseline canyon operations plan. If Rocky Flats plutonium residues and scrub alloy processing were responsible for extending canyon operations, then the extension of canyon operations would be fully charged to the Rocky Flats program. Canyon operations costs exceed $3.2 million per month. If the processing of Rocky Flats materials were also responsible for deferring the shutdown of a canyon, it would generate even higher costs for continued surveillance and maintenance. The socioeconomic impacts of extended canyon operations would be several times greater than in the maximum processing cases noted above. The duration would be much shorter, however. The regional socioeconomic impacts would be large and positive due to manpower requirements, but those effects would be brief.

4.18.4 Los Alamos National Laboratory

If salt distillation is selected as the processing technology for the other molten salt extraction and electrorefining salts, an estimated $115 million expenditure on equipment and vault upgrades will be required at the Los Alamos National Laboratory over a six- to eight-year period. Direct and indirect labor costs for this processing technology are in the range of $10 million over five years. Spread over a large number of years, these expenditures could inject $20 million per year into the local economy and generate at least as much in incremental multiplied income. Overall, several hundred jobs could be created. This amounts to several tenths of one percent of the labor force. It would also be beneficial in that the labor compensation at the Los Alamos National Laboratory is well above an otherwise low regional average and thus provides disproportionate secondary benefits. No other processing technology at the Los Alamos National Laboratory requires expenditures that could have any socioeconomic significance in the regional economic area.

4.19 MATERIALS, UTILITIES, AND ENERGY

Table 4-68 shows materials, utilities, and energy for each processing technology for Rocky Flats, the Savannah River Site, and the Los Alamos National Laboratory. At each site, the total consumption of materials, utilities, and energy is consistent with the overall requirements for other inputs and outputs, e.g., residue mass, labor, low-level waste, etc. Nitrogen usage excludes the nitrogen volume used in the nitrogen boxes

The cost for electricity in the most energy-intensive processing technology at any site (Purex processing of fused incinerator ash at the Savannah River Site H-Canyon) is in the $100,000 range. Among preferred processing technologies, Purex processing of sand, slag, and crucible at the Savannah River Site F-Canyon generates the highest costs for materials, utilities, and energy. Even so, it requires only a few thousand dollars in electricity and a few hundred dollars in steam, water, and fuel. Total program costs for any of the strategic management approaches are in the range of a few thousand dollars (for the Preferred Alternative) to a few tens of thousands of dollars.

Table 4–68
Materials, Utilities, and Energy

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
Incinerator Ash and Firebrick Fines								
Alternative 1 (No Action) [a]								
Calcine, Cement, and Store at Rocky Flats	209	0	8,883	0	391	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	326	0	0	0	786	0	0	0
Cold Ceramify at Rocky Flats	20	0	6	7	0	0	0	0
Calcine and Blend Down at Rocky Flats	128	0	698	0	0	55	5,520	0
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	162	0	0	0	280	0	16,773	0
Purex at Savannah River Site (F-Canyon)	1,197	855	14,250	0	0	0	0	3,021
(H-Canyon)	4,731	3,420	57,000	0	0	0	0	11,970
Preprocess at Rocky Flats	130	0	0	0	225	0	13,478	0
Mediated Electrochemical Oxidation at Savannah River Site (F-Canyon and H-Canyon equal)	655	462	7,707	0	0	0	0	1,665
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	209	0	8,883	0	391	0	0	0
Repackage at Rocky Flats	**37**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Sand, Slag, and Crucible Residues								
Alternative 1 (No Action) [a]								
Calcine, Cement, and Store at Rocky Flats	54	0	2,312	0	102	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	85	0	0	0	205	0	0	0
Calcine and Blend Down at Rocky Flats	33	0	182	0	0	14	1,437	0
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	**5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Purex at Savannah River Site (F-Canyon)	**152**	**113**	**1,715**	**0**	**0**	**0**	**0**	**774**
(H-Canyon)	**493**	**359**	**6,240**	**0**	**0**	**0**	**0**	**1,232**
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	54	0	2,312	0	102	0	0	0
Repackage at Rocky Flats	5	0	0	0	0	0	0	0

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.
Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
Graphite Fines								
Alternative 1 (No Action) [a]								
Calcine, Cement, and Store at Rocky Flats	13	0	568	0	25	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	21	0	0	0	50	0	0	0
Calcine and Blend Down at Rocky Flats	8	0	45	0	0	4	353	0
Alternative 3 (with Plutonium Separation)								
Preprocess at Rocky Flats	4	0	0	0	0	0	0	0
Mediated Electrochemical Oxidation at Savannah River (F-Canyon and H-Canyon equal)	42	30	493	0	0	0	0	106
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	13	0	568	0	25	0	0	0
Repackage at Rocky Flats	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Inorganic Ash								
Alternative 1 (No Action) [a]								
Calcine, Cement, and Store at Rocky Flats	22	0	914	0	40	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	33	0	0	0	81	0	0	0
Calcine and Blend Down at Rocky Flats	13	0	72	0	0	6	568	0
Alternative 4 (Combination)								
Calcine and Cement at Rocky Flats	22	0	914	0	40	0	0	0
Repackage at Rocky Flats	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
IDC 409 Salt Residues								
Alternative 1 (No Action) [a]								
Pyro-Oxidize and Store at Rocky Flats	77	0	605	0	0	57	5,744	0
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	107	0	587	0	0	46	4,649	0
Alternative 3 (with Plutonium Separation)								
Pyro-Oxidize and Salt Distill at Rocky Flats	97	0	785	0	0	75	7,451	0
Pyro-Oxidize and Water Leach at Rocky Flats	83	28	2,596	4,290	0	41	8,829	0
Pyro-Oxidize at Rocky Flats	77	0	605	0	0	57	5,744	
Salt Distill at Los Alamos National Laboratory	25		817	1,255	0	11	0	0
Salt Scrub at Rocky Flats	95	0	785	0	0	74	7,451	0
Purex at Savannah River Site (F-Canyon)	26	19	320	0	0	0	0	134
(H-Canyon)	66	48	794	0	0	0	0	167
Alternative 4 (Combination)								
Repackage at Rocky Flats	**10**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other Electrorefining and Molten Salt Extraction Salt Residues								
Alternative 1 (No Action) [a]								
Pyro-Oxidize and Store at Rocky Flats	187	0	1,468	0	0	140	13,935	0
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	261	0	1,425	0	0	113	11,280	0
Alternative 3 (with Plutonium Separation)								
Pyro-Oxidize and Salt Distill at Rocky Flats	235	0	1,904	0	0	181	18,079	0
Pyro-Oxidize and Water Leach at Rocky Flats	200	69	6,298	10,409	0	98	21,421	0
Pyro-Oxidize at Rocky Flats	187	0	1,468	0	0	140	13,935	0
Salt Distill at Los Alamos National Laboratory	61	0	1,983	3,045	0	0	0	0
Salt Scrub at Rocky Flats	229	0	1,904	0	0	181	18,079	0
Purex at Savannah River Site (F-Canyon)	201	197	2,440	0	0	0	0	1,025
(H-Canyon)	503	363	6,056	0	0	0	0	1,272
Alternative 4 (Combination)								
Repackage at Rocky Flats	**24**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
IDC 365, 413, and 427 Salt Residues								
Alternative 1 (No Action) [a]								
Pyro-Oxidize and Store at Rocky Flats	24	0	192	0	0	18	1,818	0
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	34	0	186	0	0	15	1,471	0
Alternative 3 (with Plutonium Separation)								
Pyro-Oxidize and Water Leach at Rocky Flats	36	9	822	1,358	0	13	2,794	0
Pyro-Oxidize at Rocky Flats	**24**	**0**	**192**	**0**	**0**	**18**	**1,818**	**0**
Acid Dissolve at Los Alamos National Laboratory	**58**	**0**	**2634**	**3,951**	**0**	**0**	**0**	**0**
Pyro-Oxidize at Rocky Flats	24	9	192	0	0	18	1,818	0
Water Leach at Los Alamos National Laboratory	12	0	630	1,358	0	0	976	0
Salt Scrub at Rocky Flats	30	0	248	0	0	23	2,359	0
Purex at Savannah River Site (F-Canyon)	10	7	121	0	0	0	0	51
(H-Canyon)	26	19	318	0	0	0	0	67
Alternative 4 (Combination)								
Repackage at Rocky Flats	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other Direct Oxide Reduction Salt Residues								
Alternative 1 (No Action) [a]								
Pyro-Oxidize and Store at Rocky Flats	9	0	70	0	0	7	667	0
Alternative 2 (without Plutonium Separation)								
Pyro-Oxidize and Blend Down at Rocky Flats	13	0	68	0	0	5	540	0
Alternative 3 (with Plutonium Separation)								
Pyro-Oxidize and Water Leach at Rocky Flats	10	3	301	498	0	5	1,025	0
Pyro-Oxidize at Rocky Flats	9	0	70	0	0	7	667	0
Acid Dissolve at Los Alamos National Laboratory	22	0	966	1,449	0	0	0	0
Pyro-Oxidize at Rocky Flats	9	0	70	0	0	7	667	0
Water Leach at Los Alamos National Laboratory	1	3	231	498	0	0	358	0
Salt Scrub at Rocky Flats	11	0	91	0	0	9	865	0
Purex at Savannah River Site (F-Canyon)	20	15	239	0	0	0	0	100
(H-Canyon)	53	38	632	0	0	0	0	133
Alternative 4 (Combination)								
Repackage at Rocky Flats	2	0	0	0	0	0	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.
Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
Combustible Residues								
Alternative 1 (No Action) [a] Neutralize & Dry/Desorb & Passivate/Repackage and Store at Rocky Flats	3	10	0	0	0	0	124	0
Alternative 2 (without Plutonium Separation) Sonic Wash at Rocky Flats	10	28	1,565	0	17	0	0	0
Catalytic Chemical Oxidation at Rocky Flats	40	76	3,407	27	0	0	11,981	0
Blend Down at Rocky Flats	0	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation) Mediated Electrochemical Oxidation at Rocky Flats	14	21	1,755	11	0	0	1,248	0
Alternative 4 (Combination) **Neutralize & Dry/Desorb & Passivate/ Repackage at Rocky Flats**	**3**	**10**	**0**	**0**	**0**	**0**	**124**	**0**
Plutonium Fluoride Residues								
Alternative 1 (No Action) [a] Dissolve, Oxidize, and Store at Rocky Flats	61	16	1,224	8	0	0	6,629	0
Alternative 2 (without Plutonium Separation) Blend Down at Rocky Flats	35	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation) Acid Dissolve at Rocky Flats	61	16	1,224	8	0	0	6,629	0
Preprocess at Rocky Flats								
Purex at the Savannah River Site	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
(F-Canyon)	**112**	**84**	**1,330**	**0**	**0**	**0**	**0**	**566**
(H-Canyon)	**332**	**242**	**4,200**	**0**	**0**	**0**	**0**	**846**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
IDC 331 Ful Flo Filter Media								
Alternative 1 (No Action) [a]								
Neutralize/Dry and Store at Rocky Flats	2	0	0	0	0	0	388	0
Alternative 2 (without Plutonium Separation)								
Blend Down at Rocky Flats	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Sonic Wash at Rocky Flats	8	20	1,088	0	13	0	0	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	10	15	1,319	8	0	0	939	0
IDC 338 High-Efficiency Particulate Air Filter Media								
Alternative 1 (No Action) [a]								
Neutralize/Dry and Store at Rocky Flats	4	0	0	0	0	0	887	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	25	0	0	0	0	0	0	0
Blend Down at Rocky Flats	6	0	0	0	0	0	0	0
Sonic Wash at Rocky Flats	17	45	2,486	0	29	0	2,881	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	23	35	3,016	18	0	0	2,148	0
Alternative 4 (Combination)								
Neutralize/Dry at Rocky Flats	**4**	**0**	**0**	**0**	**0**	**0**	**887**	**0**
Other High-Efficiency Particulate Air Filter Media								
Alternative 1 (No Action) [a]								
Neutralize/Dry and Store at Rocky Flats	0	0	0	0	0	0	23	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	0	0	0	0	0	0	0	0
Blend Down at Rocky Flats	0	0	0	0	0	0	0	0
Sonic Wash at Rocky Flats	0	1	65	0	0	0	0	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	1	0	39	0	0	0	28	0
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Cubic Feet)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
IDC 089, 099 and 332 Sludge Residues								
Alternative 1 (No Action) [a]								
Filter/Dry and Store at Rocky Flats	0	0	0	0	0	0	26	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	0	0	0	0	0	0	0	0
Blend Down at Rocky Flats	0	0	0	0	0	0	0	0
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Other Sludge Residues								
Alternative 1 (No Action) [a]								
Filter/Dry and Store at Rocky Flats	4	0	0	0	0	0	708	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	11	0	0	0	0	0	0	0
Blend Down at Rocky Flats	1	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation)								
Dissolve and Oxidize at Rocky Flats	66	18	1,338	11	0	0	7,240	0
Alternative 4 (Combination)								
Filter/Dry at Rocky Flats	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Glass Residues								
Alternative 1 (No Action) [a]								
Neutralize, Dry and Store at Rocky Flats	0	0	0	0	0	0	65	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	2	0	0	0	0	0	0	0
Blend Down at Rocky Flats	0	0	0	0	0	0	0	0
Sonic Wash at Rocky Flats	1	3	182	0	2	0	0	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	2	2	220	0	0	0	151	0
Alternative 4 (Combination)								
Neutralize and Dry at Rocky Flats	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.
Note: The impacts of the preferred processing technologies are presented in bold type.

	Electricity (MWh)	*Steam (kg)*	*Water (Thousands of Liters)*	*Acid (Thousands of Liters)*	*Nitrogen (Thousands of Cubic Feet)*	*Argon (Thousands of Cubic Feet)*	*Air (Thousands of Cubic Feet)*	*Fuel (Liters)*
Graphite Residues								
Alternative 1 (No Action) [a]								
Repackage and Store at Rocky Flats	4	0	0	0	0	0	0	0
Alternative 2 (without Plutonium Separation)								
Cement at Rocky Flats	25	0	1,061	0	47	0	0	0
Vitrify at Rocky Flats	38	0	0	0	0	0	0	0
Blend Down at Rocky Flats	5	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	28	43	3,688	23	0	0	2,625	0
Preprocess at Rocky Flats								
Mediated Electrochemical Oxidation at	4	0	0	0	0	0	0	0
Savannah River Site (F- and H-Canyon equal)	125	91	1,440	0	0	0	0	314
Alternative 4 (Combination)								
Repackage at Rocky Flats	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Inorganic Residues								
Alternative 1 (No Action) [a]								
Repackage and Store at Rocky Flats	0	0	0	0	0	0	0	0
Alternative 2 (without Plutonium Separation)								
Vitrify at Rocky Flats	7	0	0	0	0	0	0	0
Blend Down at Rocky Flats	1	0	0	0	0	0	0	0
Alternative 3 (with Plutonium Separation)								
Mediated Electrochemical Oxidation at Rocky Flats	5	8	705	4	0	0	501	0
Preprocess at Rocky Flats								
Mediated Electrochemical Oxidation at the								
Savannah River Site (F-Canyon and	1	0	0	0	0	0	0	0
H-Canyon equal)	31	23	350	0	0	0	0	79
Alternative 4 (Combination)								
Repackage at Rocky Flats	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Scrub Alloy								
Alternative 1 (No Action) [a]								
Repackage and Store at Rocky Flats	2	0	0	0	0	0	0	0
Alternative 2 (without Plutonium Separation)	365	0	0	0	879	0	0	0
Calcine and Vitrify at Rocky Flats								
Alternative 3 (with Plutonium Separation)								
Repackage at Rocky Flats	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Purex at Savannah River Site (F-Canyon)	**60**	**43**	**720**	**0**	**0**	**0**	**0**	**302**
(H-Canyon)	**179**	**130**	**2,160**	**0**	**0**	**0**	**0**	**454**

	Electricity (MWh)	***Steam (kg)***	***Water (Thousands of Liters)***	***Acid (Thousands of Liters)***	***Nitrogen (Thousands of Cubic Feet)***	***Argon (Thousands of Cubic Feet)***	***Air (Thousands of Cubic Feet)***	***Fuel (Liters)***

[a] Materials, utilities, and energy for storage would not be significantly above building baseline requirements.

Note: The impacts of the preferred processing technologies are presented in bold type.

In dollar terms, the costs for the materials, utilities, and energy would be very small. The cost for electricity in the most energy-intensive processing at any site (Purex processing of fused ash at Savannah River Site's H-Canyon) is in the $100,000 range. No other process requires more than a small fraction of that figure for any material, utility, or energy. For example, the 7.8 megawatt hours of electricity required for water leach of direct oxide reduction salt reduction at Los Alamos National Laboratory would cost less than $500. The total program cost for materials, utilities, and energy is likely to be no more than a few hundred thousand dollars.

4.20 IMPACTS OF THE NO ACTION ALTERNATIVE

As discussed in Chapter 2 of this EIS, DOE has identified processing technologies for each category or subcategory of plutonium residue and scrub alloy under Alternative 1 (the No Action Alternative). The impacts of these no action processing technologies are presented for each material category and subcategory in Sections 4.2 through 4.11, with each section being devoted to one material category. The impacts of the No Action Alternative were calculated by aggregating the appropriate impacts from the sets of impacts in Sections 4.2 through 4.11. All the processes in the No Action Alternative would take place at Rocky Flats, so there would be no transportation impacts in this alternative.

4.20.1 Products and Wastes

The No Action Alternative would generate stabilized residues, transuranic waste, and low-level waste. This alternative would not generate high-level waste, separated plutonium, or saltstone. The estimated amounts of the solid plutonium-bearing products and wastes are presented and compared to the onsite storage capacities in **Table 4–69**. Most of the stabilized residues would be placed in pipe components inside 208-liter (55-gal) drums as shown in Figure 2-13. The largest amount of material would be stabilized residues, most of which would be placed in safe, secure storage at Rocky Flats for an assumed 20-year period of time. The transuranic waste would be placed in safe, secure storage at Rocky Flats until WIPP is ready to receive it. DOE would need new storage facilities at Rocky Flats for the stabilized residues.

Table 4–69 Products and Wastes from the No Action Alternative

	Stabilized Residues (Drums)[a]	*Transuranic Waste (Drums)*[a]	*Low-Level Waste (Drums)*[a]
Generation	20,300	3,500	7,500
Onsite Storage Capacity	13,400[b]	13,400[b]	21,800

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] This storage capacity is for both the stabilized residues and transuranic waste combined.

The low-level waste would probably be placed in standard 208-liter (55-gal) waste drums. The low-level waste would be disposed of in one of the offsite disposal facilities routinely used by Rocky Flats, so the onsite storage capacity would probably not be necessary.

4.20.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which might result from the No Action Alternative associated with the management of all Rocky Flats plutonium residues and scrub alloy. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. The detailed site analyses are presented in Appendix D.

No construction of new processing facilities is included in this alternative, but DOE may need to modify certain existing facilities and construct new waste storage buildings at Rocky Flats. Standard site mitigation measures during any modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.20.2.1 Incident-Free Operations

Radiological Impacts—The radiological impacts to the public and the workers associated with incident-free implementation of the No Action Alternative are presented in **Table 4–70**. The impacts are those that are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of residues and scrub alloy. The post-processing storage of the stabilized residues and transuranic wastes would also produce impacts, but these are very small compared to the impacts due to processing.

The estimated total public maximally exposed individual dose is 0.00047 mrem, which applies to a hypothetical individual who lives downwind at the site boundary. This individual's chance of incurring a latent cancer fatality due to this alternative would be less than one in one billion.

Table 4–70 Radiological Impacts Due to Incident-Free Implementation of the No Action Alternative

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose[a] (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
0.00047	2.4×10^{-10}	0.012	6.0×10^{-6}
Maximally Exposed Individual Involved Worker		*Involved Worker Population*	
Dose (mrem per year)	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
2,000	0.0008	1,204	0.48

[a] The doses to the maximally exposed individual for each material category are additive because the maximum receptor location was determined to be the same for every material, regardless of whether the release location is Building 371 or Building 707 at Rocky Flats. These two buildings are near each other.

The total public population radiation dose is 0.012 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would be approximately 1,204 person-rem, which would cause 0.48 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as "noninvolved workers." The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facility would expose the involved worker population to very small incremental additional doses as discussed in Section 4.14.

Hazardous Chemical Impacts—The impacts of hazardous chemical releases associated with incident-free implementation of the No Action Alternative are presented in **Table 4–71**. Carbon tetrachloride is no longer used at Rocky Flats, but is present in small amounts in some of the residues. The probability of excess latent cancer incidence for the offsite maximally exposed individual as a result of exposure to carbon tetrachloride would be 6×10^{-11}. This hypothetical individual's chance of incurring a latent cancer would be increased by less than one in ten billion.

Table 4–71 Chemical Impacts Due to Incident-Free Implementation of the No Action Alternative

Offsite Public Maximally Exposed Individual[a]		***Offsite Public Population Number of Cancer Incidences***
Probability of Cancer Incidence	***Hazard Index***	
6×10^{-11}	0	<1[b]
Maximally Exposed Individual Worker		***Noninvolved Worker Population Number of Cancer Incidences***
Probability of Cancer Incidence	***Hazard Index***	
3×10^{-9}	0	<1[c]

[a] Only carcinogenic chemicals are released from the process; therefore, only cancer health risks are evaluated. The Hazard Index is equal to zero.
[b] In a population of 2.4 million individuals living within 80 km (50 mi) of Rocky Flats.
[c] Based on the extremely conservative assumption that the entire Rocky Flats workforce of approximately 4,600 workers would be exposed to maximally exposed individual concentration.

Carbon tetrachloride is a carcinogen that produces toxic effects in the central nervous system, pulmonary system, gastrointestinal system, and other systems in humans (Sax and Lewis 1987). The compound is an eye and skin irritant and damages the liver, kidneys, and lungs (Lewis 1991). The liver is the primary target organ for carbon tetrachloride toxicity (EPA 1991a). Less than one latent cancer would be expected to occur in the offsite population of 2.4 million individuals living within an 80-km (50-mi) radius of Rocky Flats. The maximally exposed individual worker probability of excess latent cancer incidence would be 3×10^{-9}. This hypothetical individual's risk of incurring a latent cancer would be increased by less than one chance in one hundred million. If all site workers were exposed to the maximally exposed individual concentration of carbon tetrachloride, which is an extremely conservative and unrealistic assumption, less than 1 excess latent cancer fatality would be expected to occur in the workforce population.

4.20.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents under the No Action Alternative are summarized and presented in this section. These impacts were derived directly from the sets of impacts for all the material categories presented in Sections 4.2 through 4.11. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3.

In any accident scenario the individuals most likely to be hurt are the involved workers. The risk to these workers would be due to both radiological and non-radiological effects. In a fire the involved workers could be exposed to airborne radioactive material, in addition to the smoke and heat of the fire. In an explosion, there could be flying debris and containment barriers could be broken, exposing workers to airborne radioactive material. Most spills would not have a major effect on involved workers because they would clean up the spill, wearing protective clothing and respirators as necessary. An accidental criticality could expose involved workers to large doses of prompt penetrating radiation, which could cause death in a short period of time. The earthquake and aircraft crash accident scenarios present very severe non-radiological effects to the involved workers. In these scenarios, the workers are likely to be hurt or killed from the collapse of the building or the impact of the aircraft crash before they could be evacuated.

The maximum number of involved workers at risk is estimated to be equal to the number of workers who would be working on plutonium residues or scrub alloy at any one time in each of the processing buildings at each of the three sites. Buildings 707 and 371 at Rocky Flats would each have about 100 involved workers inside, which is more involved workers than any facility at either of the other two sites. Thus, if an earthquake strong enough to collapse Building 707 and damage Building 371 hits Rocky Flats, then approximately 200 involved workers would be at risk of death or injury due to activities associated with plutonium residues and scrub alloy.

The maximum consequences for the public and a noninvolved onsite worker if DOE decides to implement the No Action Alternative are presented in **Table 4–72**. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs. The highest consequences to all three receptors would occur if a major earthquake strong enough to cause the collapse of Building 707 occurs during pyro-oxidation of the salt residues. The frequency of this earthquake is estimated to be 0.0026 per year.

Table 4–72 Maximum Accident Consequences in the No Action Alternative

Residue, Processing Technology, and Location	*Accident Frequency (per year)*	*Offsite Public Maximally Exposed Individual Consequences*		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
		Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*	*Dose (mrem)*	*Probability of a Latent Cancer Fatality*
Salt Residues, Pyro-Oxidation at Rocky Flats	0.0026	6,080	0.0030	106,000	53	68,400	0.055

Differences exist between the Rocky Flats Cumulative Impacts Document (DOE 1997) for the 1996 Baseline and this EIS in terms of the maximum accident consequences. Several factors are responsible for the differences between the two documents, and are provided below in approximate order of importance.

1. The Cumulative Impacts Document used the median value for weather conditions and this EIS uses the 95th percentile. For the earthquake accident scenario, the 95th percentile yields a calculated value of 293,000 person-rem for the population and the 50th percentile yields a calculated value of 7,000 person-rem for the population.

2. The Cumulative Impacts Document used the MACCS computer code (also used for the other Rocky Flats EISs) and this EIS uses the GENII computer code.

3. The Cumulative Impacts Document used the actual material known to be in each building, and calculated the amount of dispersible material based upon conversion of plutonium metal to oxides, amount of oxides present, amount of residues present (with associated americium amounts) and amount of transuranic and low level waste present. This EIS used a much simpler approach, in that it used two IDCs, 409 and 410, both molten salt extraction salts containing the maximum quantity of americium, as the worst case scenario, and assumed a 5-day supply to be present in Building 707 upon collapse from an earthquake.

The approach taken in this EIS does not affect the validity of the Finding of No Significant Impact decision of the Residue Stabilization Environmental Assessment, because this EIS uses the worst case approach instead of the median approach.

The aggregation of all the risks due to accidents in the No Action Alternative to the public and a noninvolved onsite worker are presented in **Table 4–73**. The increase in the probability of a latent cancer fatality to the public maximally exposed individual is estimated to be 0.000035. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand. The increase in latent cancer fatalities in the public population within 80 km (50 mi) of Rocky Flats is estimated to be 0.62, less than one latent cancer fatality. The increase in the probability of a latent cancer fatality to the noninvolved onsite worker is estimated to be 0.00061. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one thousand. More than 95 percent of the latent cancer fatality accident risks for the No Action Alternative are attributable to the salt residues.

Table 4–73 Risks Due to Accidents in the No Action Alternative

Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)	*Offsite Public Population Risk (Number of Latent Cancer Fatalities)*	*Onsite Noninvolved Worker Risk (Probability of a Latent Cancer Fatality)*
0.000035	0.62	0.00061

4.20.2.3 Mitigation Measures

All the environmental impacts in the No Action Alternative would be low, and specific mitigation measures would not be necessary. Nevertheless, DOE would maintain all public and worker exposures, both direct exposures and indirect exposures via airborne emissions, as low as reasonably achievable. As low as reasonably achievable is a long-standing DOE policy to control or manage radiation exposures and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. As low as reasonably achievable is not a dose limit but rather a process that has as its objective the attainment of dose levels as far below the applicable limits as practical.

4.21 Impacts of the Preferred Alternative

As discussed in Chapter 2, DOE has identified a variety of processing technologies for each category or subcategory of plutonium residue and scrub alloy. The impacts of all the processing technologies for each material category and subcategory are presented in Sections 4.2 through 4.11, with each section being devoted to one material category. The impacts of the Preferred Alternative were calculated by aggregating the preferred processing technology impacts from Sections 4.2 through 4.11. Some processes in the Preferred Alternative would take place at sites other than Rocky Flats, so transportation impacts would exist in this alternative.

4.21.1 Products and Wastes

The Preferred Alternative would generate high-level waste, transuranic waste, saltstone, low-level waste, and separated plutonium in the form of a metal and/or an oxide. The estimated amounts of the solid plutonium-bearing products and wastes are presented and compared to the onsite storage capacities in **Table 4–74**. The transuranic waste would be placed in safe, secure storage until WIPP is ready to receive it. The stabilized residues would not meet the safeguards termination limits, but DOE would apply variances to these limits for these residues. Thus, DOE would dispose of these stabilized residues in WIPP along with the transuranic waste with plutonium concentrations below the safeguards termination limits. Assuming WIPP opens on schedule, the transuranic waste storage capacity at Rocky Flats will be adequate in the Preferred Alternative for the transuranic wastes and stabilized residues combined. Under the Preferred Alternative, DOE would generate about 21,600 drums of stabilized residues and transuranic waste for disposal in WIPP.

The low-level waste would probably be placed in standard 208-liter (55-gal) waste drums. The low-level waste at Rocky Flats would be disposed of in one of the offsite disposal facilities routinely used by Rocky Flats. The

Savannah River Site and Los Alamos National Laboratory would use their onsite low-level waste disposal facilities. The plutonium would be ready for disposition in accordance with decisions to be reached on the *Surplus Plutonium Disposition Draft EIS* (DOE 1998b). The plutonium separated at the Savannah River Site would be stored securely in the Actinide Packaging and Storage Facility. No increase in proliferation risk would result and this plutonium would not be used for nuclear explosive purposes. The high-level waste would be stored at the Savannah River Site until a monitored geologic repository is ready to receive it. The saltstone would be disposed of at the Savannah River Site in concrete vaults.

Table 4–74 Products and Wastes from the Preferred Alternative

DOE Site	*Stabilized Residues[a] (Drums)[b]*	*Transuranic Waste (Drums)[b]*	*High-Level Waste (Canisters of Glass)[c]*	*Separated Plutonium (kg)[d]*	*Low-Level Waste (Drums)[b]*	*Saltstone (cubic meters)*
Rocky Flats Generation	18,400	2,300	0	0	4,400	0
Onsite Storage Capacity	13,400[e]	13,400[e]	0	12,900[f]	21,800	0
Savannah River Site Generation	0	50	5	469	200	500
Onsite Storage Capacity	0	74,600	2,286	20,000[g]	(h)	(h)
Los Alamos National Laboratory Generation	0	800	0	138	1,800	0
Onsite Storage Capacity	0	116,900	0	2,700[i]	(h)	0

[a] These stabilized residues could be disposed of in WIPP as transuranic waste.
[b] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[c] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[d] To convert to pounds, multiply by 2.2
[e] This storage capacity is for both the stabilized residues and transuranic waste combined.
[f] This is the amount of plutonium that was stored at Rocky Flats as of September 1994. DOE has analyzed the shipment of the plutonium to the Savannah River Site and the Pantex Plant in the Storage and Disposition of Weapons-Usable Fissile Materials Environmental Impact Statement (DOE 1996a).
[g] The new Actinide Packaging and Storage Facility is being designed with positions for 5,000 storage containers (DOE 1997d). Each container holds at least 4 kg of plutonium, so the capacity of the Actinide Packaging and Storage Facility will be at least 20,000 kg of plutonium.
[h] The site routinely disposes of this waste onsite.
[i] This is the amount of plutonium that was stored at the Los Alamos National Laboratory as of September 1994 (DOE 1996a).

4.21.2 Public and Occupational Health and Safety Impacts

This section describes the radiological and hazardous chemical impacts which could result from the Preferred Alternative associated with the management of all Rocky Flats plutonium residues and scrub alloy. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. The detailed site and transportation analyses are presented in Appendices D and E, respectively.

If DOE decides to implement the Preferred Alternative, then DOE would make 39 shipments to the Savannah River Site and 3 shipments to the Los Alamos National Laboratory. The total round-trip highway distance would be about 208,000 kilometers (129,000 miles).

No construction of new processing facilities is included in this alternative but DOE may need to modify certain existing facilities and construct new waste storage buildings if shipments to WIPP are delayed. Standard mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.21.2.1 Incident-Free Operations

Radiological Impacts—The radiological impacts to the public and the workers associated with incident-free implementation of the Preferred Alternative are presented in **Table 4–75**. The impacts are those which are anticipated to occur as a result of process operations and transportation over whatever time period is necessary to process the entire inventory of plutonium residues and scrub alloy.

The length of time necessary to process all the material will depend on which technologies DOE decides to implement. The post-processing storage of the high-level waste, transuranic waste, and plutonium would also produce impacts, but these are very small compared to the impacts due to processing.

Table 4–75 Radiological Impacts Due to Incident-Free Implementation of the Preferred Alternative

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
11	5.5×10^{-6}	4.0	0.0020
Maximally Exposed Individual Worker		***Noninvolved Worker Population***	
Dose (mrem per year)	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
2,000	0.00080	682	0.27

The estimated total public maximally exposed individual dose, as shown in Table 4–75, is 11 mrem, which applies to a hypothetical member of the public stuck in traffic next to a safe secure trailer for one-half hour. See discussion in Section 4.2.2.1 regarding the conservative nature of this analysis. This individual's chance of incurring a latent cancer fatality due to this alternative would be 5.5×10^{-6}, or less than one chance in one hundred thousand. The public maximally exposed individual near any of the sites would be a hypothetical individual who lives downwind at the site boundary. The highest estimated total dose for this maximally exposed individual would be 0.00057 mrem at the Savannah River Site. This individual's chance of incurring a latent cancer fatality due to this alternative would be less than one in one billion.

The total public population radiation dose, as shown in Table 4–75, would be 4.0 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero. The highest public population radiation dose (excluding transportation) was determined to be 0.062 person-rem to the population surrounding the Savannah River Site, which would cause far less than one additional latent cancer fatality to this population. During incident-free storage, there would be no release of radioactive material, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would be 682 person-rem, which would cause 0.27 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as noninvolved workers. The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facilities would expose the involved worker population to very small incremental additional doses, as discussed in Section 4.14.

Hazardous Chemical Impacts—The impacts of hazardous chemical releases associated with incident-free processing under the Preferred Alternative are presented in **Table 4–76**. The probability of excess latent cancer incidence for the offsite maximally exposed individual would be 6×10^{-11}. This hypothethical individual's chance of incurring a latent cancer would be increased by less than one in ten billion. Less than one latent cancer would be expected to occur in the offsite population of 2.4 million individuals living within an 80-km (50-mi) radius of Rocky Flats. The maximally exposed individual worker probability of excess latent cancer incidence would be 3×10^{-9}. This hypothetical individual's risk of incurring a latent cancer would be increased by less than one chance in one hundred million. If all site workers were exposed to the maximally exposed individual concentration of carbon tetrachloride, which is an extremely conservative and unrealistic assumption, less than one excess latent cancer fatality would be expected to occur in the workforce population. The Hazard Index value of 5×10^{-9} suggests that noncancer adverse health effects are not expected in the offsite population at the Savannah River Site following exposure to phosphoric acid and ammonium nitrate. The Hazard Index value of 6×10^{-8} suggests that noncancer adverse health effects are not expected in the worker population.

Table 4–76 Chemical Impacts Due to Incident-Free Implementation of the Preferred Alternative

Offsite Public Maximally Exposed Individual		*Offsite Public Population*[a]	
Probability of Cancer Incidence	***Hazard Index***[b]	***Number of Cancer Incidences***	***Number of Latent Cancer Fatalities***
6×10^{-11}	5×10^{-9}	< 1	0.00052[c]
Maximally Exposed Individual Worker		***Noninvolved Worker Population***	
Probability of Cancer Incidence	***Hazard Index***[b]	***Number of Cancer Incidences***	***Number of Latent Cancer Fatalities***
3×10^{-9}	6×10^{-8}	< 1	(c)

[a] Cancer incidences and fatalities are calculated for process emissions and transportation emissions, respectively.
[b] Highest value for materials processed at the Savannah River Site under this alternative.
[c] Number of cancer fatalities due to vehicle emissions. The impact is listed only once under public population because the vehicle emissions affect the public and worker populations collectively; however, the risk to the public dominates.

The impacts of vehicle emissions associated with incident-free transportation under the Preferred Alternative are also presented in Table 4–76. The health effect due to these vehicle emissions would be 0.00062 latent cancer fatalities. This is much less than one, so DOE would not expect any latent cancer fatalities due to the vehicle emissions.

4.21.2.2 Accidents

The potential radiological impacts to the public and the noninvolved onsite workers due to accidents under the Preferred Alternative are summarized and presented in this section. These impacts were derived directly from the sets of impacts for all the material categories presented in Sections 4.2 through 4.11. The detailed analysis of onsite accidents, with the associated assumptions, is presented in Appendix D, Section D.3. The detailed analysis of transportation accidents, with the associated assumptions, is presented in Appendix E, Sections E.5 and E.6.

In any accident scenario the individuals most likely to be hurt are the involved workers. The risk to these workers would be due to both radiological and non-radiological effects. In a fire the involved workers could be exposed to airborne radioactive material, in addition to the smoke and heat of the fire. In an explosion, there could be flying debris and containment barriers could be broken, exposing workers to airborne radioactive material. Most spills would not have a major effect on involved workers because they would clean up the spill, wearing protective clothing and respirators as necessary. An accidental criticality could expose involved workers to large doses of prompt penetrating radiation, which could cause death in a short period of time. The earthquake and aircraft crash accident scenarios present very severe non-radiological effects to the involved workers. In these scenarios, the workers are likely to be hurt or killed from the collapse of the building or the impact of the aircraft crash before they could be evacuated.

The maximum number of involved workers at risk is estimated to be equal to the number of workers who would be working on plutonium residues or scrub alloy at any one time in each of the processing buildings at each of the three sites. Buildings 707 and 371 at Rocky Flats would each have about 100 involved workers inside, which is more involved workers than any facility at either of the other two sites. Thus, if an earthquake strong enough to collapse Building 707 and damage Building 371 hits Rocky Flats, then approximately 200 involved workers would be at risk of death or injury due to activities associated with plutonium residues and scrub alloy.

The maximum consequences for the public and a noninvolved onsite worker if DOE decides to implement the Preferred Alternative, are presented in **Table 4–77**. The public maximally exposed individual is a hypothetical individual who resides at the site boundary in the downwind direction. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs. The highest consequence to all three receptors would occur if a major earthquake strong enough to collapse Building 707 occurs during the repackaging of high-assay salt residues at Rocky Flats.

Table 4–77 Maximum Accident Consequences in the Preferred Alternative

		Offsite Public Maximally Exposed Individual Consequences		*Offsite Public Population Consequences*		*Noninvolved Onsite Worker Consequences*	
Residue, Processing Technology, and Location	***Accident Frequency (per year)***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***
Salt Residues							
Repackage at Rocky Flats	0.0026	20,300	0.020	356,000	178	229,000	0.18

The aggregation of all the risks due to accidents in the Preferred Alternative to the public and an onsite worker are presented in **Table 4–78**. The increase in the probability of a latent cancer fatality to the public maximally exposed individual is estimated to be 0.000038. This individual's chance of incurring a latent cancer fatality would be increased by less than one in ten thousand. The offsite public population risk is the summation of the risks due to radiological releases at the three sites, radiological releases along the transportation routes, and traffic fatalities. The total public population risk for the Preferred Alternative would be 0.64 latent cancer or traffic fatalities. The increase in the probability of a latent cancer fatality to the noninvolved onsite worker is estimated to be 0.00070. This individual's chance of incurring a latent cancer fatality would be increased by less than one in one thousand. More than 80 percent of the latent cancer fatality accident risks for the Preferred Alternative are attributable to the salt residues.

Table 4–78 Risks Due to Accidents in the Preferred Alternative

Offsite Public Maximally Exposed Individual Risk (Probability of a Latent Cancer Fatality)	*Offsite Public Population Risk (Number of Latent Cancer or Traffic Fatalities)*	*Noninvolved Onsite Worker Risk (Probability of a Latent Cancer Fatality)*
0.000038	0.64	0.00070

4.21.2.3 Mitigation Measures

All the environmental impacts in the Preferred Alternative would be low and within regulatory limits, so specific mitigation measures would not be necessary. Nevertheless, DOE would maintain all public and worker exposures, both direct exposures and indirect exposures via airborne emissions, as low as reasonably achievable. As low as reasonably achievable is a long-standing DOE policy to control or manage radiation exposures and releases of radioactive material to the environment as low as social, technical, economic, practical, and public policy considerations permit. As low as reasonably achievable is not a dose limit but rather a process that has as its objective the attainment of dose levels as far below the applicable limits as practical.

4.22 COMPARISON OF THE IMPACTS OF THE STRATEGIC MANAGEMENT APPROACHES

As discussed in Chapter 2, Section 2.5, eight Strategic Management Approaches have been constructed by selecting a processing technology for each of the 19 material categories and/or subcategories. The primary impacts of the eight Strategic Management Approaches are presented in **Table 4-79**. These impacts have been derived from the impacts presented for each material category in Sections 4.2 through 4.11. Seven of the Strategic Management Approaches would satisfy United States nonproliferation policy. Only the No-Action Alternative would allow nuclear nonproliferation concerns to continue.

4.22.1 Products and Wastes

The amounts of primary solid plutonium-bearing products and wastes that would be generated under the Strategic Management Approaches are compared in **Figures 4-1** through **4-5**.

For each Strategic Management Approach, except for No Action, the quantity of waste that could be sent to WIPP for disposal as transuranic waste is the sum of the quantities of drums shown in Figures 4-1 and 4-2. Under the Preferred Alternative, DOE would generate about 21,600 drums of processed residues and secondary waste that would be sent to WIPP for disposal. Under the No Action alternative, no processed residues would be disposed of.

The processed residues and secondary transuranic wastes that would be generated under the alternatives in this EIS are broken down into the two groupings shown in Figures 4-1 and 4-2 to distinguish between processed materials that would be below the safeguards termination limits and could thus be sent to WIPP, and those materials that would be above the safeguards termination limits and could only be sent to WIPP under a variance to safeguards termination limits:

- The term "Stabilized Residues," as used in the title of Figure 4-1, refers to processed materials that would still be above the safeguards termination limits even after processing under the action alternatives. The "stabilized residues" produced under the No Action alternative would be stored onsite and would not be sent to WIPP for disposal because their plutonium content would exceed the safeguards termination limits. The other "stabilized residues" that could be produced under this EIS would result from Alternative 4 and would be subject to a variance. As a result, they could be disposed of in WIPP.

- The term "Transuranic Waste," as used in the title of Figure 4-2, refers to those materials that would be below the safeguards termination limits after processing under the alternatives of this EIS. It includes both the processed residues and secondary transuranic waste that would be produced during the processing operation.

To reiterate, for the action alternatives of this EIS, the quantities in Figures 4-1 and 4-2 must be summed to determine the amount of transuranic waste that could be sent to WIPP.

Figure 4-4 shows the amounts of plutonium that could be separated from the plutonium residues and scrub alloy. Two of the management approaches (No Action and Process without Plutonium Separation) do not involve any plutonium separation. Under the Preferred Alternative, DOE would separate roughly one-quarter of the plutonium that could be separated under the Maximum Plutonium Separation Management Approach. If any plutonium is separated, it would be placed in safe, secure storage until DOE makes decisions on its disposal or other disposition. DOE would not use this plutonium for nuclear explosive purposes.

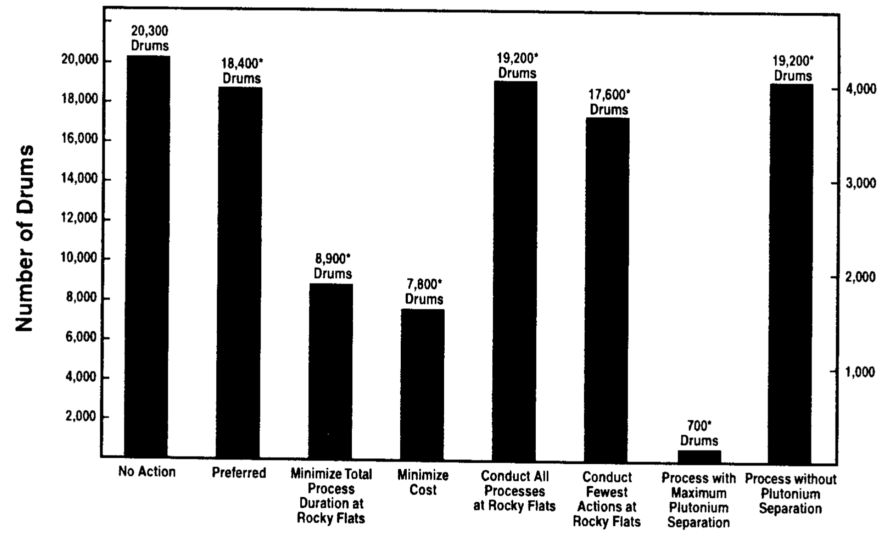
Table 4–79 Impacts of the Strategic Management Approaches

Impact	*Strategic Management Approaches*							
	No Action	*Preferred*	*Minimize Total Process Duration at Rocky Flats*	*Minimize Cost*	*Conduct all Processes at Rocky Flats*	*Conduct Fewest Actions at Rocky Flats*	*Process with Maximum Plutonium Separation*	*Process without Plutonium Separation*
Products and Wastes								
Stabilized Residues (drums) [a]	20,300	**18,400 [b]**	8,900 [b]	7,800 [b]	19,200 [b]	17,600 [b]	700 [b]	19,200 [b]
Transuranic Waste (drums) [a, c]	3,500	**3,200**	6,600	3,400	5,600	3,200	9,300	9,200
High-Level Waste (canisters) [d]	0	**5**	2	1	0	5	42	0
Separated Plutonium (kilograms) [e]	0	**607**	1,082	1,279	141	607	2,709	0
Low-Level Waste (drums) [a]	7,500	**6,400**	10,400	4,900	5,500	6,400	19,900	4,800
Radiological Public and Occupational Health and Safety								
Incident-Free Radiological Risk to the Public Maximally Exposed Individual (Probability of a Latent Cancer Fatality)	2.4×10^{-10}	$\mathbf{5.5\times10^{-6}}$	5.5×10^{-6}	5.5×10^{-6}	1.2×10^{-10}	5.5×10^{-6}	5.5×10^{-6}	9.4×10^{-11}
Incident-Free Radiological Risk to the Public Population (Latent Cancer Fatalities)	6.0×10^{-6}	**0.0020**	0.0016	0.00083	4.0×10^{-6}	0.0020	0.0079	3.5×10^{-6}
Incident-Free Radiological Risk to the Maximally Exposed Individual Worker (Probability of a Latent Cancer Fatality per year)	0.0008	**0.0008**	0.0008	0.0008	0.0008	0.0008	0.0008	0.0008
Incident-Free Radiological Risk to the Worker Population (Latent Cancer Fatalities)	0.48	**0.27**	0.25	0.24	0.28	0.27	0.34	0.40
Worker Hazard Index	<<1	**<<1**	<<1	<<1	<<1	<<1	<<1	<<1
Accident Risk to the Public Maximally Exposed Individual (Probability of a Latent Cancer Fatality)	0.000035	**0.000038**	0.000032	0.000035	0.000036	0.000038	0.000046	0.000036
Accident Risk to the Public Population (Latent Cancer or Traffic Fatalities)	0.62	**0.64**	0.53	0.62	0.64	0.64	0.67	0.65
Accident Risk to the Noninvolved Onsite Worker (Probability of a Latent Cancer Fatality)	0.00061	**0.00070**	0.00062	0.00065	0.00067	0.00070	0.00085	0.00067

Impact	Strategic Management Approaches: No Action	Preferred	Minimize Total Process Duration at Rocky Flats	Minimize Cost	Conduct all Processes at Rocky Flats	Conduct Fewest Actions at Rocky Flats	Process with Maximum Plutonium Separation	Process without Plutonium Separation
Other Impacts								
Intersite Round-Trip Transportation (1,000 kilometers) [f]	0	**208**	166	84	0	208	823	0
Cost (million $) [f, g, h]	1,129 [i,j]	**524 [k]**	482[j,l,m]	428 [k]	510 [j]	668 [j]	814 [p]	539 [k]
Processing Duration at Rocky Flats (years) [q]	7.2	**5.5 [m,n]**	2.6 [l,m]	3.2 [m]	5.1	2.8 [m,o]	3.4 [l,m]	10.2
Air Quality Impacts	no exceedances (See Sections 4.12 and 4.25)	**no exceedances (See Sections 4.12 and 4.25)**	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)	no exceedances (See Sections 4.12 and 4.25)
Nuclear Nonproliferation Considerations	(r)	**(s)**	(s)	(s)	(s)	(s)	(s)	(s)

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] These stabilized residues could be disposed of in WIPP as transuranic waste.
[c] Transuranic waste includes secondary waste, such as disposable clothing and contaminated laboratory equipment.
[d] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680) kg) of high-level waste glass.
[e] To convert to pounds, multiply by 2.2.
[f] To convert thousands of kilometers to thousands of miles, multiply by 0.62.
[g] Decisional costs for labor, site overheads, itemized equipment, residue and waste processing, waste shipment and disposal, and fissile materials disposition, plus non-decisional costs for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work. Excludes adjustments for technical or schedule uncertainties.
[h] Undiscounted 1997 dollars.
[i] Includes $460 million for 20 years of interim storage at Rocky Flats.
[j] Includes $220 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.
[k] Includes $190 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.
[l] Processing duration at Los Alamos Nuclear Laboratory is about six months.
[m] Includes processes at Savannah River Site F-Canyon. Processing durations at the Savannah River Site depend on schedules for materials in programs outside the scope of this EIS.
[n] Processing duration at Los Alamos Nuclear Laboratory is about four months.
[o] Processing duration at Los Alamos Nuclear Laboratory depends on the type of new salt distillation equipment and the timing of its installation. The duration therefore depends on schedules for materials in programs outside the scope of this EIS.
[p] Includes $250 million for facilities upgrades, equipment, operational readiness reviews, start-up testing, and technology and development work that is allocable to the clean-up of plutonium residues at Rocky Flats.
[q] Sum of durations for processing technologies with the shortest individual processing time at Rocky Flats. All processes at different buildings or modules at Rocky Flats are conducted concurrently. The sum of the shortest individual processing times does not necessarily equal the shortest processing time at the site since longer duration processing technologies at one facility may shorten the total duration at the site. Processing duration does not reflect technical or schedule uncertainties, deferred start-up due to technology demonstration and testing, or schedule interactions among processing technologies, facilities, or sites.
[r] The plutonium residues and scrub alloy would be left in forms that cannot be disposed of due to nuclear nonproliferation considerations.

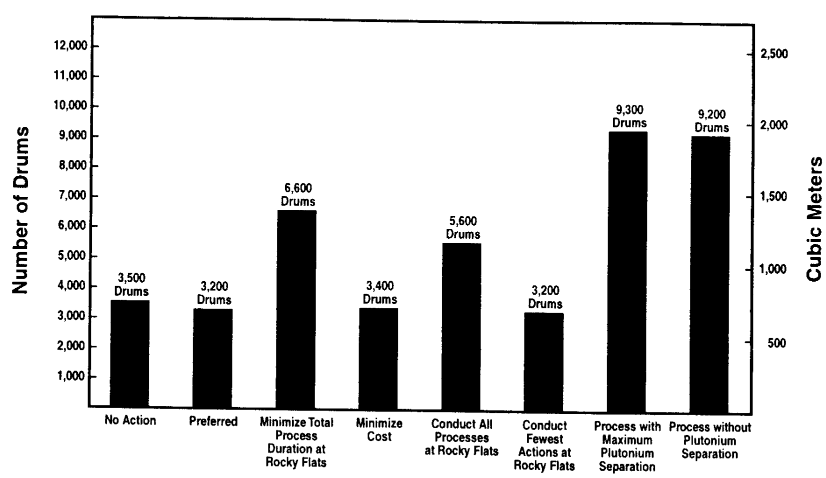
- The plutonium residues and scrub alloy would be managed and placed in forms that can be disposed of or dispositioned in a manner that supports United States nuclear weapons nonproliferation policy.



* These stabilized residues would be suitable for disposal in WIPP as transuranic waste.

NOTE: On average, the material would fill less than one-fourth of the volume of each drum. The volume of each drum is 0.208 cubic meter (55 gallons).

Figure 4–1 Stabilized Residues Generated Under Each Strategic Management Approach



NOTE: On average, the material would fill less than one-fourth of the volume of each drum. The volume of each drum is 0.208 cubic meter (55 gallons).

Figure 4–2 Transuranic Waste Generated Under Each Strategic Management Approach

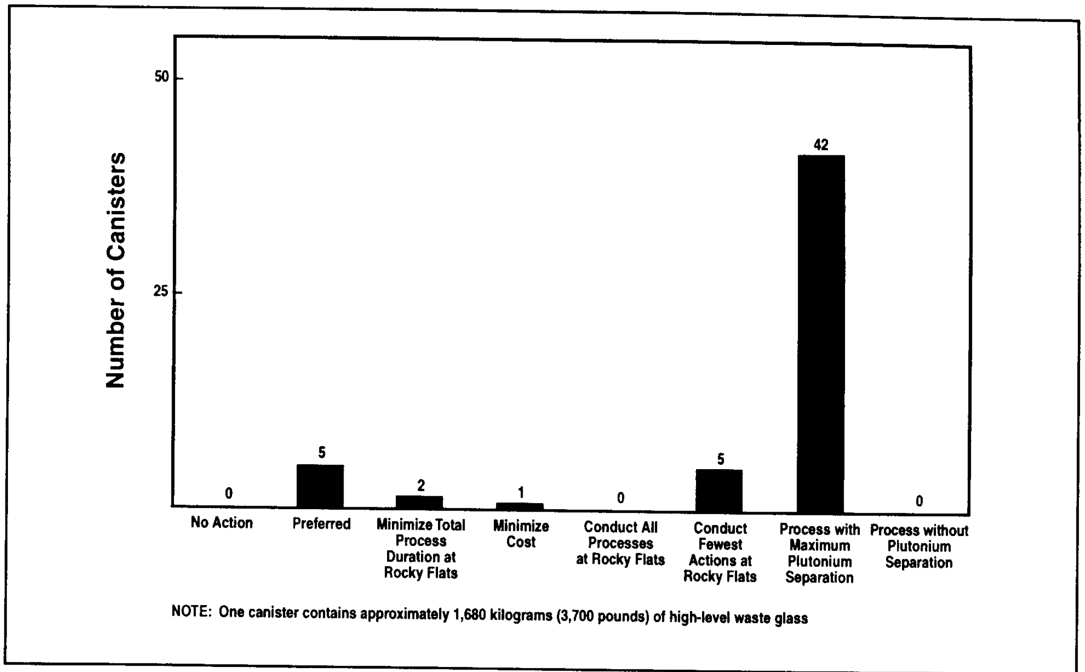


Figure 4–3 High-Level Waste Generated Under Each Strategic Management Approach

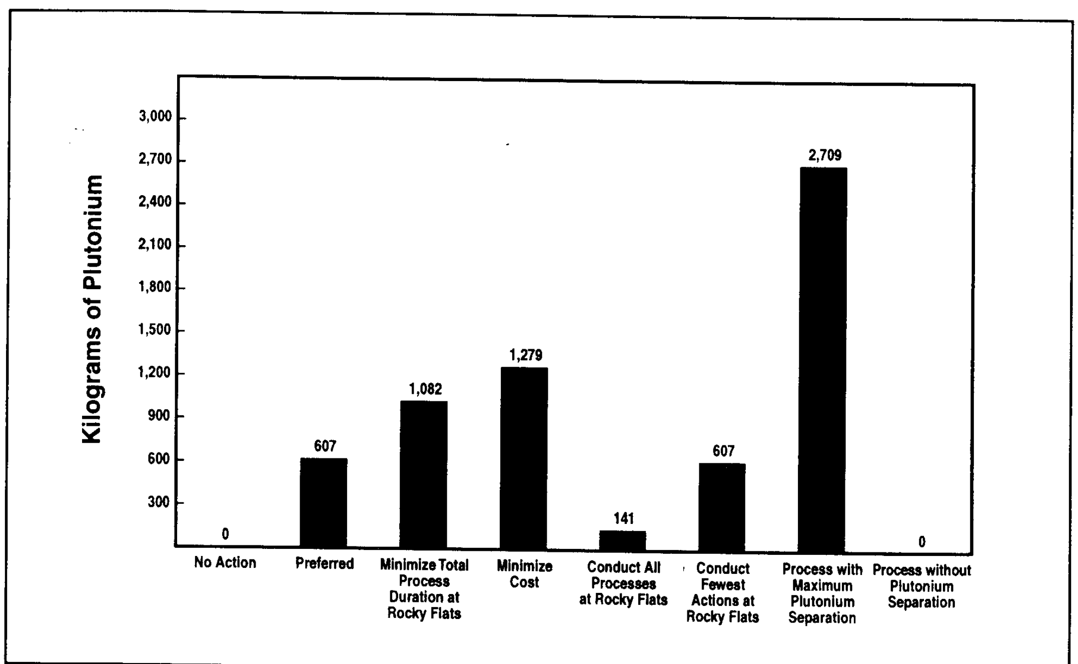


Figure 4–4 Plutonium Separated Under Each Strategic Management Approach

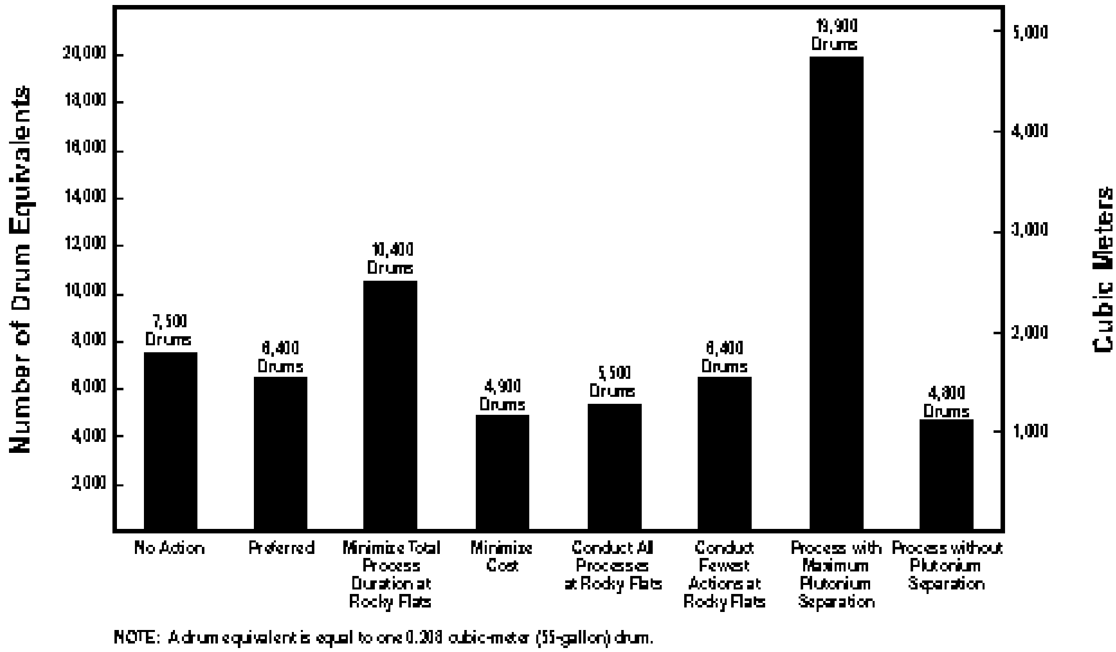


Figure 4–5 Low-Level Waste Generated Under Each Strategic Management Approach

The amounts of material to be managed as high-level waste and of low-level radioactive wastes that would be generated under each management approach are shown in Figures 4-3 and 4-5. The Process with Maximum Plutonium Separation Management Approach would generate the most material to be managed as high-level waste and also the most low-level waste. The Preferred Alternative would generate significantly smaller quantities of these wastes than this approach.

4.22.2 Public and Occupational Health and Safety Impacts

All of the Stratgic Management Approaches present low risks to the public and to workers. DOE estimates less than one additional latent cancer fatality to occur in the general public as a result of radiation exposure, no matter which Strategic Management Approach is selected. Nevertheless, differences exist between the risks presented by the eight Strategic Management Approaches. **Figures 4–6** through **4-12** display the risk comparisons for the public and workers under both incident-free and accident conditions.

As shown in Figure 4–6, the Strategic Management Approaches with intersite transportation would involve greater risk to the public maximally exposed individual than those without intersite transportation. A conservative upper-bound estimate of the chance that this hypothetical individual would incur a latent cancer fatality would be about 5.5×10^{-6}, or less than one chance in one hundred thousand. As shown in Figure 4–7, one Strategic Management Approach presents a risk of about 0.0079 additional latent cancer fatalities, while the Preferred Alternative presents a risk of only 0.0020 additional latent cancer fatalities. In all cases the estimated risks are so low that no member of the public would be likely to incur a latent cancer fatality due to incident-free operations.

As shown in Figure 4–8, all the Strategic Management Approaches are equal in terms of the annual risk to the maximally exposed individual involved worker. This is because DOE applied the same conservative assumption across the board for this part of the analysis. This assumption is the DOE Administrative Control level of 2,000 mrem per year. Most of the risk comparisons in this EIS are based on the total amounts of

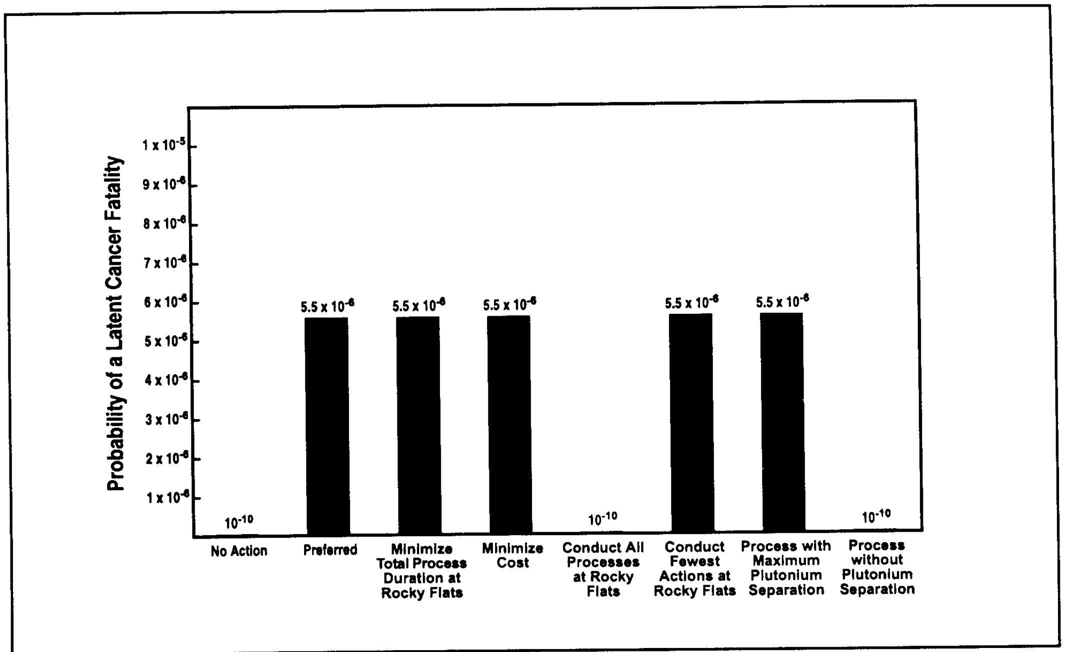


Figure 4–6 Incident-Free Radiological Risk to the Public Maximally Exposed Individual Under Each Strategic Management Approach

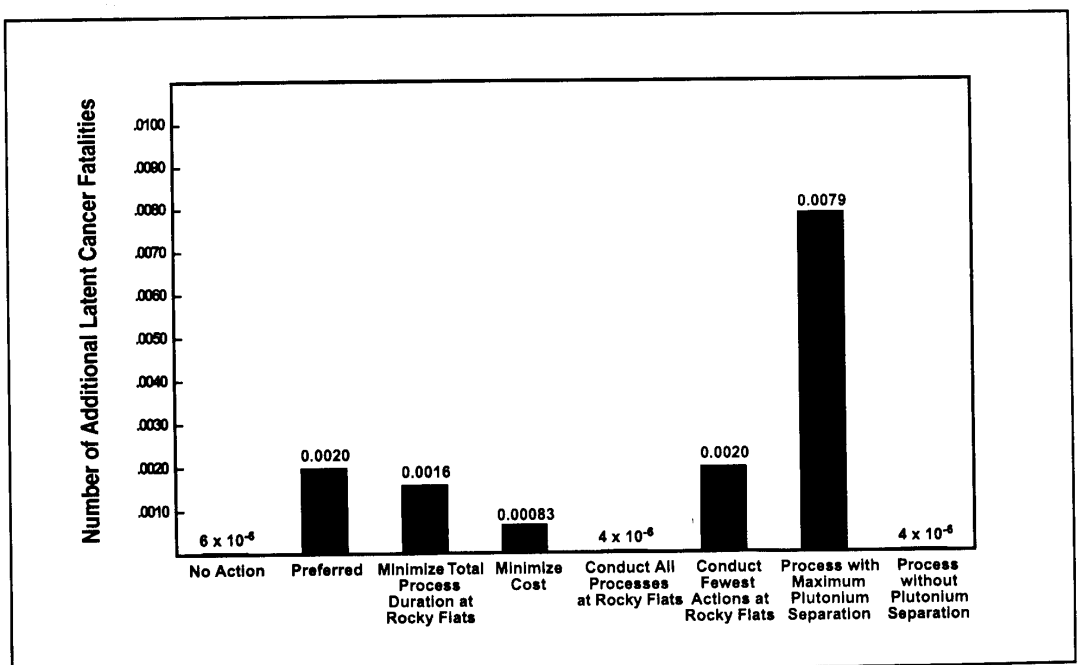


Figure 4–7 Incident-Free Radiological Risk to the Public Population Under Each Strategic Management Approach

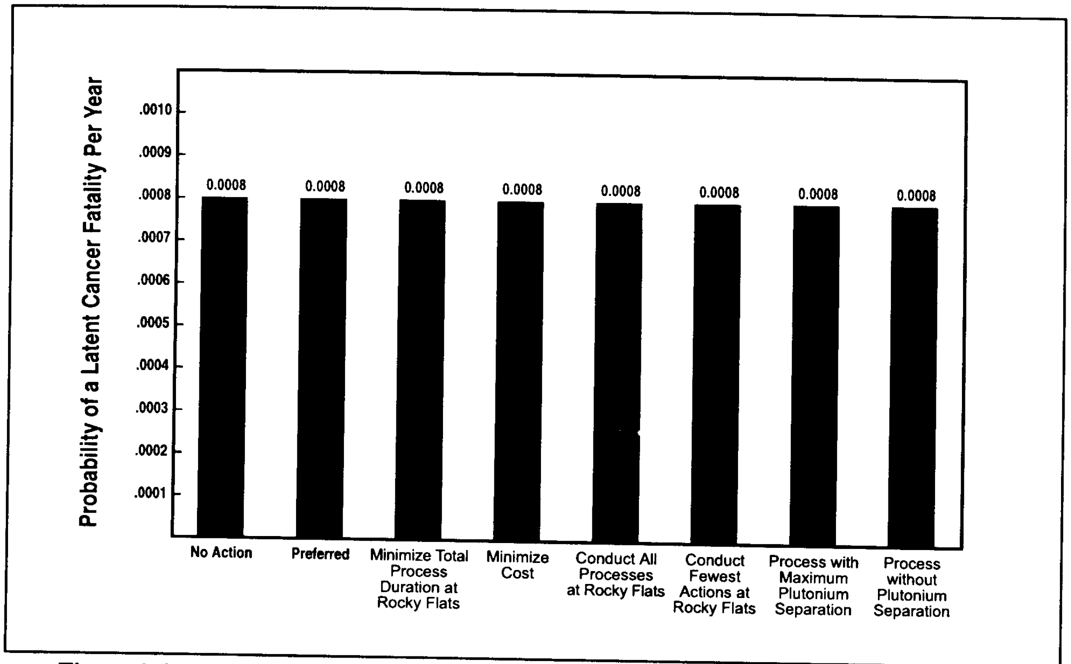


Figure 4–8 Incident-Free Radiological Risk to the Maximally Exposed Individual Worker Under Each Strategic Management Approach

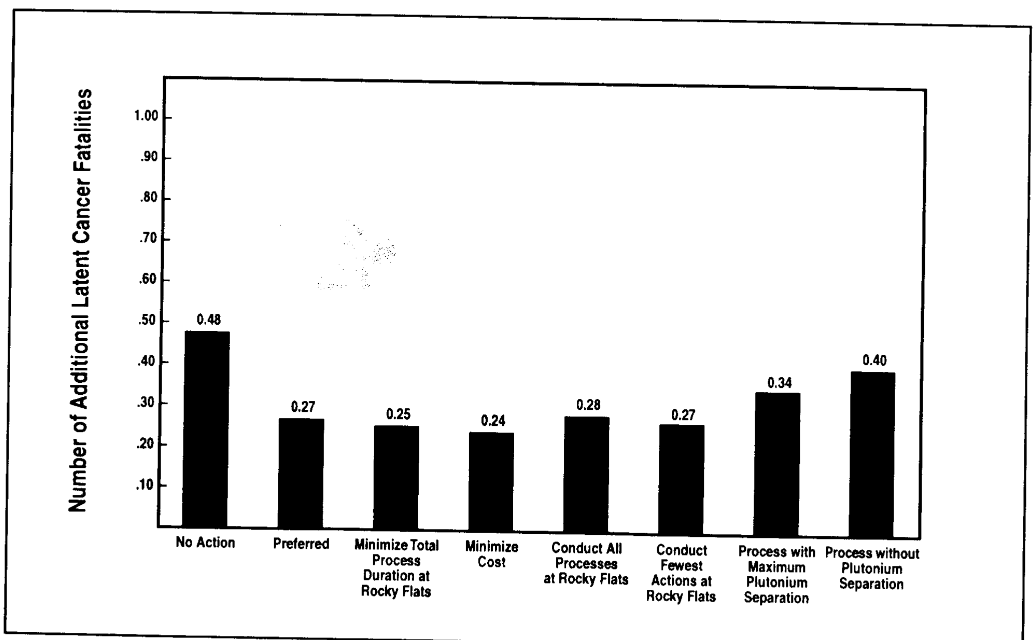


Figure 4–9 Incident-Free Radiological Risk to the Worker Population Under Each Strategic Management Approach

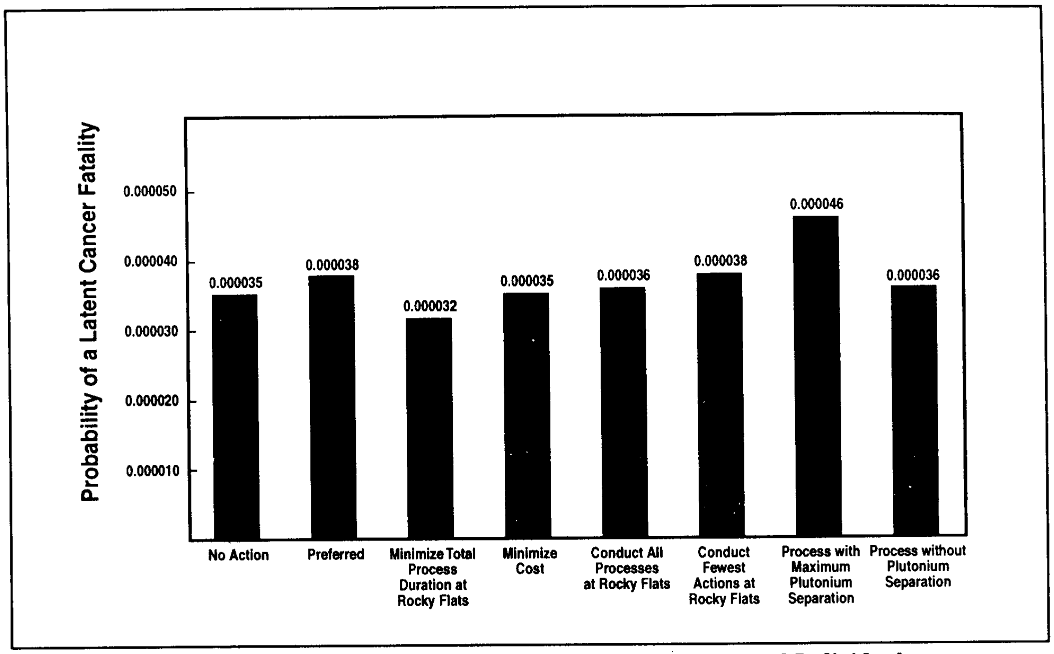


Figure 4–10 Accident Risk to the Public Maximally Exposed Individual Under Each Strategic Management Approach

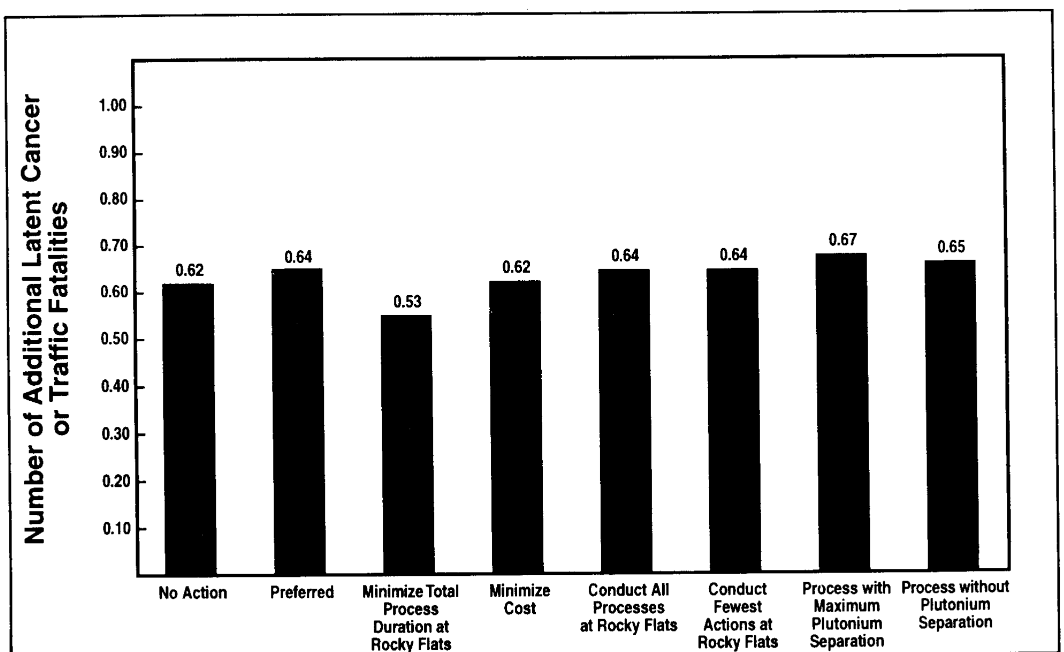


Figure 4–11 Accident Risk to the Public Population Under Each Strategic Management Approach

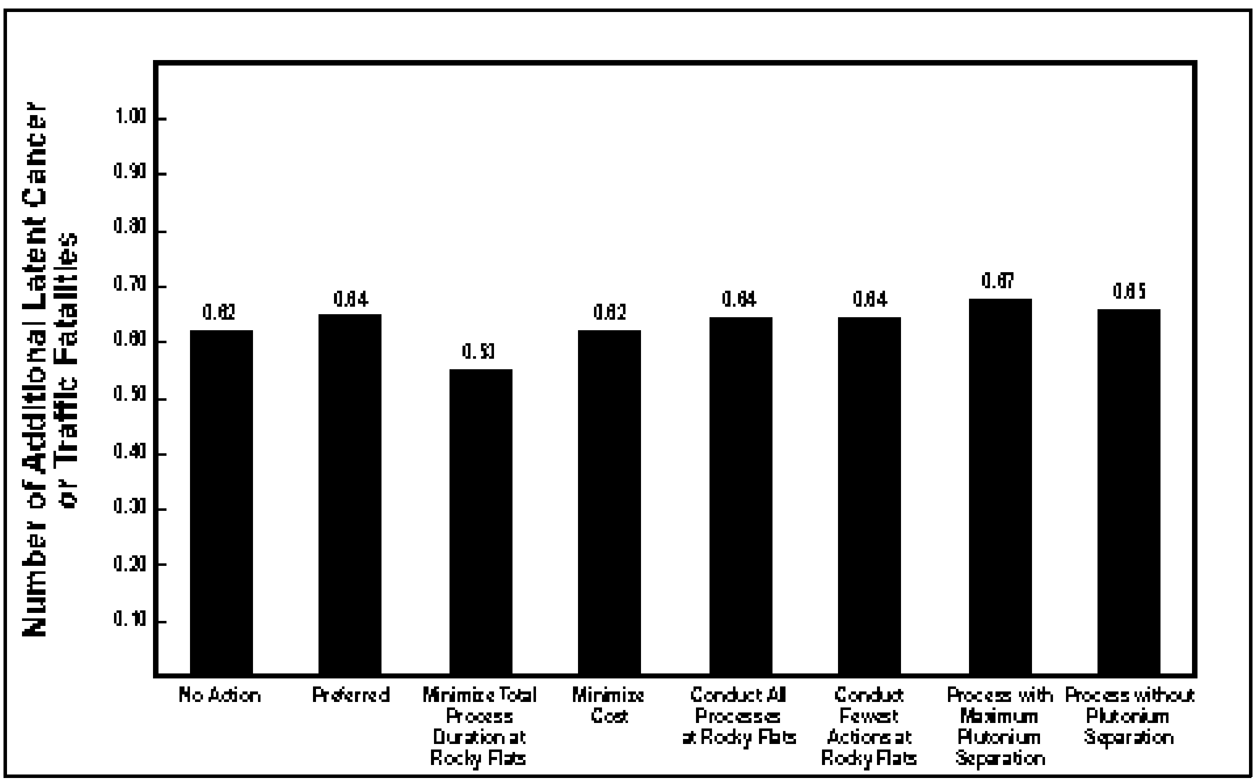


Figure 4–11 Accident Risk to the Public Population Under Each Strategic Management Approach

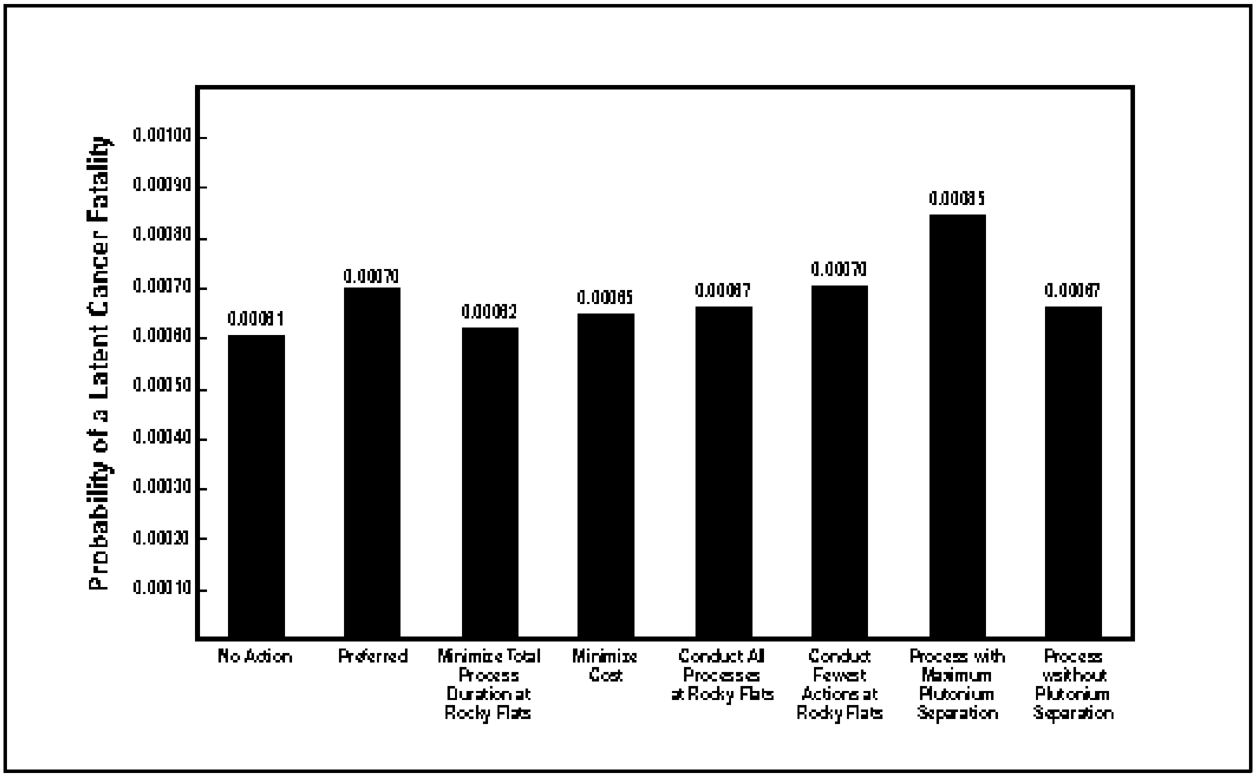


Figure 4–12 Accident Risk to the Noninvolved Onsite Worker Under Each Strategic Management Approach

residue and scrub alloy, but this one is an annual risk comparison. As shown in Figure 4–9, all the Strategic Management Approaches would cause less than 0.5 additional latent cancer fatalities among the worker population. DOE would not expect any additional worker latent cancer fatalities under any of these alternatives or management approaches. During post-processing storage, inspections of the storage facilities would expose the involved worker population to very small incremental additional doses, as discussed in Section 4.14.

As shown in Figures 4–10, 4–11, and 4–12, the risks due to onsite and transportation accidents do not vary greatly among any of the Strategic Management Approaches. In general, the Minimize Total Process Duration at Rocky Flats Management Approach presents somewhat lower accident risks than the rest of the Strategic Management Approaches, but all the accident risks are low.

4.22.3 Other Impacts

Five of the eight Strategic Management Approaches involve intersite transportation of plutonium residues and/or scrub alloy. **Figure 4-13** compares the intersite transportation that would be required under each alternative in terms of round-trip highway distances. The Process with Maximum Plutonium Separation Management Approach would require about 823,000 km (511,000 mi) of intersite transportation, while the Preferred Alternative would require about 208,000 km (129,000 mi).

The cost comparison is presented in **Figure 4-14**. Cost estimates range from $428 million for the Minimum Cost Alternative to over $1.1 billion for the No Action Alternative. The Preferred Alternative has an estimated cost of $524 million.

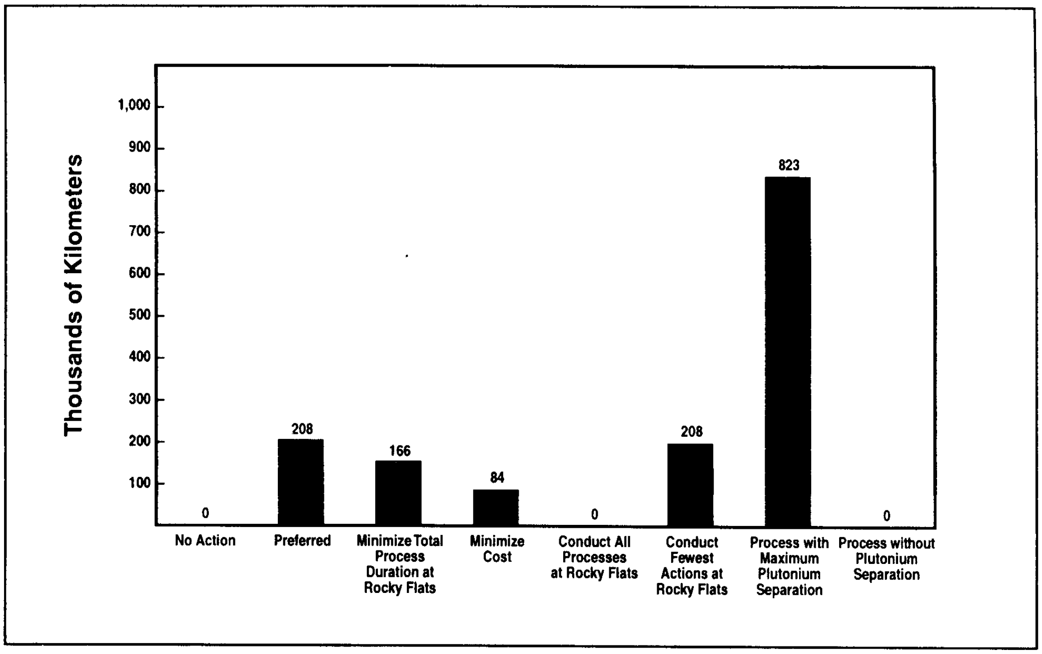


Figure 4–13 Intersite Round-Trip Transportation Required Under Each Strategic Management Approach

4.23 RANGE OF IMPACTS AT EACH SITE

As discussed in Chapter 2, DOE has identified a variety of technologies for each category or subcategory of plutonium residue and scrub alloy under Alternative 1 (No Action) and Alternative 2 (the Proposed Action). The impacts of all the technologies are presented for each residue category and subcategory in Sections 4.2 through 4.11, with each section being devoted to one residue category.

All the residues can be processed at Rocky Flats and portions of the residues can be processed at the Savannah River Site or Los Alamos National Laboratory. Sections 4.23.1 through 4.23.3 present the range of impacts that could result from the processing technology associated with the management of certain plutonium residues and scrub alloy at Rocky Flats, the Savannah River Site, and Los Alamos National Laboratory, respectively. The low end of the range for all impacts at the Savannah River Site and at Los Alamos National Laboratory is zero; this would result if all processing were to take place at Rocky Flats or at Rocky Flats and only one other site.

4.23.1 Rocky Flats Environmental Technology Site

4.23.1.1 Products and Wastes

The processing technologies at Rocky Flats would generate stabilized residues, transuranic waste, low-level waste, and separated plutonium (with americium included) in the form of an oxide. Considering all possible processing technologies, the minimum and maximum estimated amounts of the solid plutonium-bearing products and wastes that could be generated from plutonium residues and scrub alloy at Rocky Flats are presented in **Table 4–80**. The transuranic waste would be placed in safe, secure storage until WIPP is ready to receive it. The low-level waste would be disposed of in one of the offsite disposal facilities routinely used

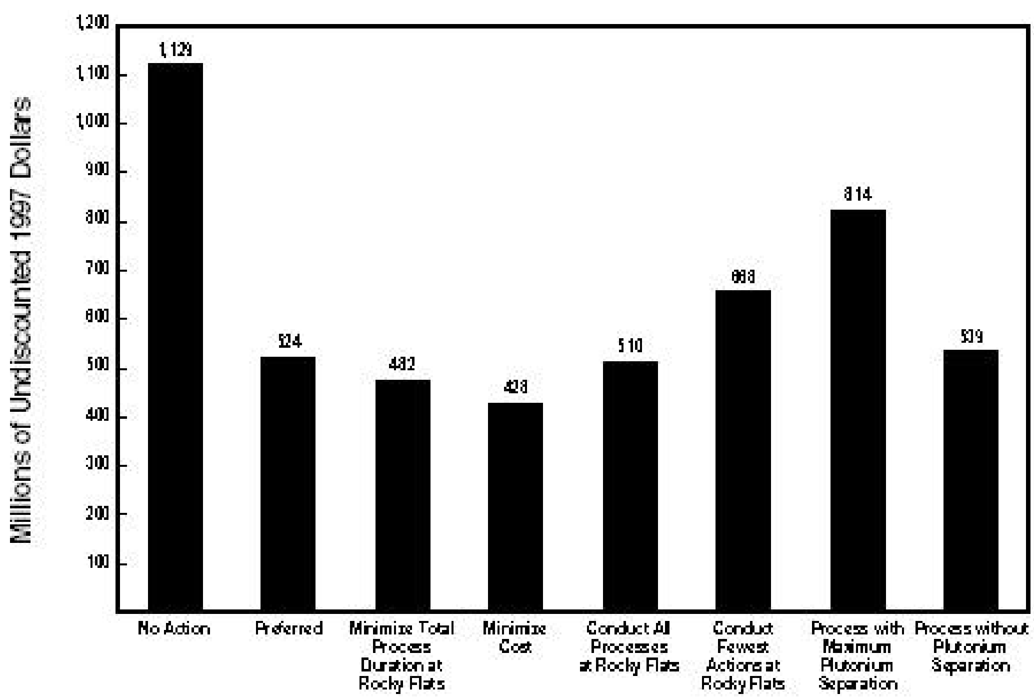


Figure 4–14 Cost of Each Strategic Management Approach

by Rocky Flats.

Table 4–80 Range of Products and Wastes at Rocky Flats

Stabilized Residues (Drums) [a]	*Transuranic Waste (Drums)* [a]	*Separated Plutonium (kg)* [b]	*Low-Level Waste (Drums)* [a]
0 to 21,300	2,000 to 39,200	0 to 1,399	4,100 to 57,900

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] To convert to pounds, multiply by 2.2.

As shown in Table 4–74, the storage capacity available at Rocky Flats for stabilized residues and transuranic waste combined is 13,400 drums. Table 4–80 shows that this storage capacity could be insufficient to accommodate stabilized residues and transuranic waste. This problem would only occur if DOE selects a set of processing technologies that generate large amounts of stabilized residues and transuranic waste and shipments to WIPP are delayed. In this case, a new storage facility would have to be constructed at Rocky Flats.

If, on the other hand, DOE selects the Preferred Alternative and WIPP opens on time, then the existing transuranic waste storage capacity will be adequate.

4.23.1.2 Public and Occupational Health and Safety Impacts

This section describes the range of radiological and hazardous chemical impacts which could result from the various processing technologies associated with the management of Rocky Flats plutonium residues and scrub alloy at Rocky Flats. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. Detailed analyses associated with these impacts are presented in Appendix D.

No construction of new facilities is required for any of the alternatives, but DOE may need to modify certain existing facilities. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.23.1.2.1 Incident-Free Operations

Radiological Impacts—The range of radiological impacts to the public and the workers associated with incident-free implementation of the various processing technologies at Rocky Flats is presented in **Table 4–81**. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the entire inventory of plutonium residues and scrub alloy. The length of time necessary to process all the plutonium residues and scrub alloy will depend on which technologies DOE decides to implement. The post-processing storage of the high-level waste, transuranic waste, and plutonium would also produce worker impacts, but these are very small compared to the impacts due to processing (see Section 4.14).

Table 4–81 Range of Radiological Impacts Due to Incident-Free Operations at Rocky Flats

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
0.00012 to 0.00105	6.0×10^{-11} to 5.3×10^{-10}	0.0046 to 0.024	2.3×10^{-6} to 0.000012

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
Maximally Exposed Individual Involved Worker		*Involved Worker Population*	
Dose (mrem per year)	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
2,000	0.00080	425 to 2,040	0.17 to 0.82

The public maximally exposed individual at Rocky Flats would be a hypothetical individual who lives downwind at the site boundary. As shown in Table 4–81, the estimated total dose for this maximally exposed individual could range from about 0.0001 mrem to 0.001 mrem. This individual's chance of incurring a latent cancer fatality due to process operations would be less than one in one billion.

The total public population radiation dose, as shown in Table 4–81, could range from 0.0046 person-rem to 0.024 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would range from 425 person-rem to 2,040 person-rem, which would cause 0.17 to 0.82 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as noninvolved workers. The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facility would expose the involved worker population to very small incremental additions.

Hazardous Chemical Impacts—The range of impacts of hazardous chemical releases associated with incident-free implementation of the various processing technologies at Rocky Flats is presented in **Table 4–82**. The probability of excess latent cancer incidence for the offsite population maximally exposed individual resulting from releases of carbon tetrachloride ranges from 0 to 6×10^{-11}. This hypothetical individual's chance of incurring a latent cancer would be increased by less than one in ten billion. From zero to less than one latent cancer incidence is expected to occur in the offsite population of 2.4 million individuals living within an 80-km (50-mi) radius of Rocky Flats. The Hazard Index range of 0 to 5×10^{-11} resulting from releases of hydrochloric acid suggests that noncancer adverse health effects are not expected in the offsite population.

Table 4–82 Range of Chemical Impacts at Rocky Flats

Offsite Public Maximally Exposed Individual		*Offsite Public Population*
Probability of Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities*
0 to 6×10^{-11}	0 to 5×10^{-11}	0 to <1
Maximally Exposed Individual Worker		*Noninvolved Worker Population*
Probability of Cancer Incidence	*Hazard Index*	*Number of Cancer Incidences or Fatalities*
0 to 3×10^{-9}	0 to 3×10^{-9}	0 to <1

The maximally exposed individual involved worker probability of excess latent cancer incidence ranges from 0 to 3×10^{-9}. This hypothetical individual's chance of incurring a latent cancer would be increased by less than one in one hundred million. If all site workers were exposed to the maximally exposed individual concentration of carbon tetrachloride, which is an extremely conservative and unrealistic assumption, less than 1 excess latent cancer would be expected to occur in the workforce population. The Hazard Index range of 0 to 3×10^{-9} suggests that noncancer adverse health effects are not expected in the involved worker population as a result of exposure to hydrochloric acid.

4.23.1.2.2 Accidents

The range of radiological impacts to the public and the noninvolved onsite workers due to accidents during the implementation of the various processing technologies for plutonium residues and scrub alloy at Rocky Flats is presented in **Table 4–83**. The length of time necessary to process all the residues and scrub alloy will depend on which technologies DOE decides to implement.

Table 4–83 Range of Radiological Impacts[a] Due to Accidents at Rocky Flats

Offsite Public Maximally Exposed Individual Risk	*Offsite Public Population Risk*	*Noninvolved Onsite Worker Maximally Exposed Individual Risk*
Probability of a Latent Cancer Fatality	***Number of Latent Cancer Fatalities***	***Probability of a Latent Cancer Fatality***
0.0000027 to 0.000042	0.031 to 0.66	0.000027 to 0.00067

[a] The impacts are given as risks, which are additive, rather than consequences, which are not additive for accidents.

The public maximally exposed individual at Rocky Flats would be a hypothetical individual who lives downwind at the site boundary. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

The estimated risk of a latent cancer fatality for the maximally exposed individual could range from 0.0000027 to 0.000042. This individual's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in ten thousand. The estimated risk of latent cancer fatalities for the general population could be in the range of 0.031 to 0.66. This accident risk could cause one additional latent cancer fatality in the population living near Rocky Flats. The noninvolved onsite worker risk is in the range of 0.000027 to 0.00067. This noninvolved onsite worker's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in one thousand.

In any accident scenario, the individuals most likely to be injured are the involved workers. The risk to these workers would be due to both radiological and nonradiological effects. In a fire, the involved workers could be exposed to airborne radioactive material, in addition to the smoke an heat of the fire. In an explosion, there could be flying debris and containment barriers could be broken, exposing workers to airborne radioactive material. Most spills would not have a major effect on involved workers because they would clean up the spill wearing protective clothing and respirators as necessary. An accidental criticality could expose involved workers to large doses of prompt penetrating radiation, which could cause death in a short period of time. The earthquake and aircraft crash accident scenarios present very severe nonradiological effects to the involved workers. In these scenarios, the workers are likely to be hurt or killed from the collapse of the building or the impact of the aircraft crash before they could be evacuated.

The maximum number of involved workers at risk is estimated to be equal to the number of workers who would be working on plutonium residues or scrub alloy at any one time in each of the processing buildings at each of the three sites. Building 707 and 371 at Rocky Flats would each have about 100 involved workers inside, which is more involved workers than any facility at either of the other two sites. Thus, if an earthquake strong enough to collapse Building 707 and damage Building 371 hits Rocky Flats, approximately 200 involved workers would be at risk of death or injury due to activities associated with plutonium residues and scrub alloy. The estimated frequencies of earthquakes that could collapse Buildings 707 and 371 are 0.0026 and 0.000094 per year, respectively.

4.23.2 Savannah River Site

4.23.2.1 Products and Wastes

The processing technologies at the Savannah River Site would generate high-level waste, transuranic waste, saltstone, low-level waste, and separated plutonium in the form of a metal and/or an oxide. The americium from the residues would go into the high-level waste. Considering all possible processing technologies, the minimum and maximum estimated amounts of the solid plutonium-bearing products and wastes that could be generated from plutonium residues and scrub alloy at the Savannah River Site are presented in **Table 4–84**. The transuranic waste would be placed in safe, secure storage until WIPP is ready to receive it. The high-level waste canisters would be stored onsite until a monitored geologic repository is ready to receive them. The separated plutonium would be stored onsite until a decision is made on its disposition. The low-level waste and saltstone would be disposed of in the onsite disposal facilities at the Savannah River Site.

Table 4–84 Range of Products and Wastes at the Savannah River Site

Transuranic Waste (Drums)[a]	*High-Level Waste (Canisters of Glass)[b]*	*Separated Plutonium (kg)[c]*	*Low-Level Waste (Drums)[a]*	*Saltstone (cubic meters)*
0 to 500	0 to 43	0 to 2,521	0 to 1,100	0 to 2,500

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[c] To convert to pounds, multiply by 2.2.

4.23.2.2 Public and Occupational Health and Safety Impacts

This section describes the range of radiological and hazardous chemical impacts which could result from the various processing technologies associated with the management of certain Rocky Flats residues and scrub alloy at the Savannah River Site. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. Detailed analyses associated with these impacts are presented in Appendix D.

No construction of new facilities is required for any of the alternatives, but DOE may need to modify certain existing facilities. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.23.2.2.1 Incident-Free Operations

Radiological Impacts—The range of radiological impacts to the public and the workers associated with incident-free implementation of the various processing technologies at the Savannah River Site is presented in **Table 4–85**. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the applicable inventory of residues and scrub alloy. The length of time necessary to process the residues and scrub alloy will depend on which technologies DOE decides to implement. The post-processing storage of the high-level waste, transuranic waste, and plutonium would also produce impacts, but these are very small compared to the impacts due to processing.

Table 4–85 Range of Radiological Impacts Due to Incident-Free Operations at the Savannah River Site

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
0 to 0.0034	0 to 1.7×10^{-9}	0 to 0.38	0 to 0.00019
Maximally Exposed Individual Involved Worker		***Involved Worker Population***	
Dose (mrem per year)	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
0 to 2,000	0 to 0.00080	0 to 469	0 to 0.19

The public maximally exposed individual at the Savannah River Site would be a hypothetical individual who lives downwind at the site boundary. As shown in Table 4–85, the estimated total dose for this maximally exposed individual could range from 0 mrem to 0.0034 mrem. This individual's chance of incurring a latent cancer fatality due to process operations would be less than one in one-hundred million.

The total public population radiation dose, as shown in Table 4–85, could range from 0 person-rem to 0.38 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would range from 0 to approximately 469 person-rem, which would cause 0 to 0.19 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as noninvolved workers. The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facility would expose the involved worker population to small incremental additions. When the Actinide Packaging and Storage Facility becomes operational, these inspections will be done remotely, so the worker dose will go down to zero.

Hazardous Chemical Impacts—The range of impacts of hazardous chemical releases associated with incident-free implementation of the various processing technologies at the Savannah River Site is presented in **Table 4–86**. No carcinogenic chemicals are expected to be released from the processing of plutonium residues and scrub alloy at the Savannah River Site; therefore, maximally exposed individual cancer probability and population cancer incidences were not evaluated for the offsite population or workers. The Hazard Index range of 0 to 2×10^{-9} suggests that noncancer adverse health effects are not expected in the offsite population as a result of releases of phosphoric acid and ammonium nitrate. The Hazard Index range of 0 to 2×10^{-8} indicates that onsite workers are not expected to experience adverse noncancer health effects.

Table 4–86 Range of Chemical Impacts at the Savannah River Site

Offsite Public Maximally Exposed Individual		*Offsite Public Population*
Probability of Cancer Incidence	***Hazard Index***	***Number of Cancer Incidences***
N/A	0 to 2×10^{-9}	N/A

Maximally Exposed Individual Worker		*Noninvolved Worker Population*
Probability of Cancer Incidence	***Hazard Index***	***Number of Cancer Incidences***
N/A	0 to 2×10^{-8}	N/A

N/A = not applicable

4.23.2.2.2 Accidents

The range of radiological impacts to the public and the noninvolved onsite workers due to accidents during the implementation of the various processing technologies for plutonium residues and scrub alloy at the Savannah River Site is presented in **Table 4–87**. The length of time necessary to process all the residues and scrub alloy will depend on which technologies DOE decides to implement.

Table 4–87 Range of Radiological Impacts Due to Accidents at the Savannah River Site

Offsite Public Maximally Exposed Individual Risk	*Offsite Public Population Risk*	*Noninvolved Onsite Worker Maximally Exposed Individual Risk*
Probability of a Latent Cancer Fatality	***Number of Latent Cancer Fatalities***	***Probability of a Latent Cancer Fatality***
0 to 2.5×10^{-7}	0 to 0.011	0 to 0.000078

[a] The impacts are given as risks, which are additive, rather than consequences, which are not additive for accidents.

The public maximally exposed individual at the Savannah River Site would be a hypothetical individual who lives downwind at the site boundary. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

The estimated risk of a latent cancer fatality for the maximally exposed individual could range from 0 to 2.5×10^{-7}. This individual's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in one million. The estimated risk of latent cancer fatalities for the general population could be in the range of 0 to 0.011. The noninvolved onsite worker risk is in the range of 0 to 0.000078. This onsite worker's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in ten thousand.

4.23.3 Los Alamos National Laboratory

4.23.3.1 Products and Wastes

The processing technologies at Los Alamos National Laboratory would generate high-level waste, transuranic waste, and low-level waste, and would also produce separated plutonium in the form of an oxide. Considering all possible processing technologies, the minimum and maximum estimated amounts of the solid plutonium-bearing products and wastes that could be generated from plutonium residues and scrub alloy at the Los Alamos National Laboratory are presented in **Table 4–88**. The transuranic waste would be placed in safe, secure storage until WIPP is ready to receive it. The low-level waste would be disposed of at the onsite disposal facilities at Los Alamos National Laboratory.

Table 4–88 Range of Products and Wastes at Los Alamos National Laboratory

Transuranic Waste (Drums)[a]	*Separated Plutonium (kg)[b]*	*Low-Level Waste (Drums)[a]*
0 to 3,000	0 to 980	0 to 6,200

[a] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.)
[b] To convert to pounds, multiply by 2.2.

4.23.3.2 Public and Occupational Health and Safety Impacts

This section describes the range of radiological and hazardous chemical impacts which could result from the processing technologies associated with the management of certain Rocky Flats residues at the Los Alamos National Laboratory. These impacts are presented for incident-free operations and postulated accident scenarios, respectively. Detailed analyses associated with these impacts are presented in Appendix D.

No construction of new facilities is required for any of the alternatives, but DOE may need to modify certain existing facilities. Mitigation measures during modifications would ensure that any radiological or hazardous chemical releases would be extremely small. Worker exposures to contaminated material would be limited to ensure that doses are maintained as low as reasonably achievable.

4.23.3.2.1 Incident-Free Operations

Radiological Impacts—The range of radiological impacts to the public and the workers associated with incident-free implementation of applicable processing technologies at Los Alamos National Laboratory is presented in **Table 4–89**. The impacts are those which are anticipated to occur as a result of process operations over whatever time period is necessary to process the inventory of applicable residues. The length of time necessary to process the residues will depend on which technology(s) DOE decides to implement. The post-processing storage of the high-level waste, transuranic waste, and plutonium would also produce impacts, but these are very small compared to the impacts due to processing.

Table 4–89 Range of Radiological Impacts Due to Incident-Free Operations at Los Alamos National Laboratory

Offsite Public Maximally Exposed Individual		*Offsite Public Population*	
Dose (mrem)	*Probability of a Latent Cancer Fatality*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
0 to 0.00080	0 to 4.0×10^{-10}	0 to 0.0024	0 to 1.2×10^{-6}
Maximally Exposed Individual Involved Worker		*Involved Worker Population*	
Dose (mrem per year)	*Probability of a Latent Cancer Fatality per year*	*Dose (person-rem)*	*Number of Latent Cancer Fatalities*
0 to 2,000	0 to 0.00080	0 to 160	0 to 0.064

The public maximally exposed individual at Los Alamos National Laboratory would be a hypothetical individual who lives downwind at the site boundary. As shown in Table 4–89, the estimated total dose for this maximally exposed individual could range from 0 mrem to 0.00080 mrem. This individual's chance of incurring a latent cancer fatality due to process operations would be less than one in one-billion.

The total public population radiation dose, as shown in Table 4–89, could range from 0 person-rem to 0.0024 person-rem. During incident-free storage, no release of radioactive material would occur, so the impact on the public would be equal to zero.

The total involved worker population radiation dose would range from 0 person-rem to approximately 160 person-rem, which would cause 0 to 0.064 additional latent cancer fatalities among the workers directly involved in the operations. Onsite workers who are not involved with the actual processing of the residues are designated as noninvolved workers. The impacts to these workers would be much smaller than the impacts to the involved workers. During the post-processing storage period, inspections of the storage facility would expose the involved worker population to small incremental additions.

Hazardous Chemical Impacts—No hazardous chemicals are expected to be released from the proposed processing of plutonium residues at Los Alamos National Laboratory under the various processing technologies evaluated in this EIS.

4.23.3.2.2 Accidents

The range of radiological impacts to the public and the noninvolved onsite workers due to accidents during the implementation of the various processing technologies for plutonium residues at Los Alamos National Laboratory is presented in **Table 4–90**. The length of time necessary to process all the residues will depend on which technologies DOE decides to implement.

Table 4–90 Range of Radiological Impacts Due to Accidents at Los Alamos National Laboratory

Offsite Public Maximally Exposed Individual Risk	*Offsite Public Population Risk*	*Noninvolved Onsite Worker Maximally Exposed Individual Risk*
Probability of a Latent Cancer Fatality	*Number of Latent Cancer Fatalities*	*Probability of a Latent Cancer Fatality*
0 to 0.000028	0 to 0.037	0 to 0.00048

[a] The impacts are given as risks, which are additive, rather than consequences, which are not additive for accidents.

The public maximally exposed individual at the Los Alamos National Laboratory would be a hypothetical individual who lives downwind at the site boundary. The public population is defined as the residential population within a radius of 80 km (50 mi). A noninvolved onsite worker is defined as an individual worker who is located 100 m (328 ft) or more downwind from the release point when an accidental release of radioactive material occurs.

The estimated risk of a latent cancer fatality for the maximally exposed individual could range from 0 to 0.000028. This individual's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in ten thousand. The estimated risk of latent cancer fatalities for the general population could be in the range of 0 to 0.037. The noninvolved onsite worker risk is in the range of 0 to 0.00048. This noninvolved onsite worker's chance of incurring a latent cancer fatality due to an accident during process operations would be increased by less than one in one thousand.

4.24 RANGE OF INTERSITE TRANSPORTATION IMPACTS

As discussed in Chapter 2, DOE has identified a variety of options under Alternative 3, Process with Plutonium Separation, that would require transporting plutonium residues or scrub alloy from Rocky Flats to either the Savannah River Site or Los Alamos National Laboratory. Considering all the options, the number of truck shipments from Rocky Flats to the Savannah River Site could range from zero to 208. Similarly, the number of truck shipments from Rocky Flats to Los Alamos National Laboratory could range from zero to 63. The detailed analysis of the intersite transportation impacts are presented in Appendix E, Sections E.5 and E.6.

The range of radiological impacts due to incident-free transportation along each potential transportation route is presented in **Table 4–91**. These results are all based on the conservative assumption that the dose rate is 10 mrem per hour at 2 m (6.6 ft) from the side of the truck. See Section 4.2.2.1 for additional information on the conservative nature of the transportation analyses. For every impact, the low end of the range is always zero because some options involve no transportation. The high end of each range is always very low, which indicates that DOE would expect no latent cancer fatalities from any combination of transportation options.

Table 4–91 Range of Offsite Radiological Impacts Due to Incident-Free Offsite Transportation

	Public Maximally Exposed Individual		*Public Population*	
Origin/Destination	***Dose (mrem)***	***Probability of a Latent Cancer Fatality***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
Rocky Flats/Savannah River Site	0 to 11	0 to 5.5×10^{-6}	0 to 21	0 to 0.010
Rocky Flats/Los Alamos National Laboratory	0 to 11	0 to 5.5×10^{-6}	0 to 1.7	0 to 0.00085
	Maximally Exposed Individual Transport Worker		***Transport Worker Population***	
Origin/Destination	***Dose (mrem per year)***	***Probability of a Latent Cancer Fatality per year***	***Dose (person-rem)***	***Number of Latent Cancer Fatalities***
Rocky Flats/Savannah River Site	0 to 100	0 to 0.000040	0 to 32	0 to 0.013
Rocky Flats/Los Alamos National Laboratory	0 to 100	0 to 0.000040	0 to 2.6	0 to 0.0010

The only chemical impact would be latent cancer fatalities due to vehicle exhaust. The vehicle exhaust gases from the maximum number of truck shipments (round-trip) from Rocky Flats to the Savannah River Site and Los Alamos National Laboratory could cause up to 0.0027 and 0.00029 latent cancer fatalities, respectively.

The potential impacts due to transportation accidents are presented in **Table 4–92**. For every impact, the low end of the range is always zero because some options involve no transportation. The table shows that the risk of prompt death due to the trauma of a traffic accident is much greater than the risk due to radiological exposure following an accident. The highest risk is 0.021, which means that there would be about a 2-percent chance of one traffic fatality if DOE decides to make all 208 possible truck shipments to the Savannah River Site.

Table 4–92 Range of Risks Due to Transportation Accidents

	Offsite Public Population Radiological Risk	***Offsite Public and Worker Trauma Risk***
Origin/Destination	***Number of Latent Cancer Fatalities***	***Probability of One Traffic Fatality***
Rocky Flats/Savannah River Site	0 to 6.0×10^{-6}	0 to 0.021
Rocky Flats/Los Alamos National Laboratory	0 to 3.6×10^{-7}	0 to 0.0018

4.25 KEY CUMULATIVE IMPACTS AT THE POTENTIAL PROCESSING SITES AND DURING INTERSITE TRANSPORTATION

All of the potential processing sites for the Rocky Flats plutonium residues and scrub alloy have facilities unrelated to the management of these materials. These other facilities may continue to operate throughout the same period during which the residues and scrub alloy are processed (approximately 5 to 10 years). Impacts from operation of the plutonium residue and scrub alloy processing facilities would be cumulative with the impacts of existing and planned facilities or actions such as environmental restoration and waste management activities which are unrelated to processing and management of the residues and scrub alloy.

This section presents the cumulative impacts at each of the three sites that may process residues and scrub alloy. It also presents the cumulative impacts of transporting these materials for potential processing at the Savannah River Site and at Los Alamos National Laboratory. To obtain the cumulative site impacts, the range of impacts from processing the residues and scrub alloy at each site are added to the impacts from existing and planned actions unrelated to residue or scrub alloy processing. The impacts from existing and planned actions are taken from the information presented in the Waste Management Programmatic Environmental Impact Statement (DOE 1997c). Cumulative impacts from transportation are derived from information given in Section 4.24 and Appendix E.

In compliance with the Clean Air Act (42 U.S.C. 7401), EPA has promulgated National Ambient Air Quality Standards for six criteria air pollutants (40 CFR Part 50): carbon monoxide (CO), sulfur dioxide (SO_2), particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM_{10}), ozone (O_3), nitrogen dioxide (NO_2), and lead (Pb). These pollutants are regulated both in terms of annual production in tons per year and in terms of ambient concentrations emanating from point and mobile sources. Unlike the other five criteria air pollutants, ozone is not a direct emission but is formed in the atmosphere through a complex reaction of ozone precursor pollutants, sunlight, and temperature. Ozone precursor pollutants include nitrogen oxides (NO_X) and nonmethane hydrocarbons, which include the class of compounds known as volatile organic compounds.

Criteria air pollutants can be emitted from equipment used to modify facilities, vehicles from workers traveling to and from the site, from operation and maintenance of processing facilities, and from safe, secure trailers used to transport plutonium residues and scrub alloy from Rocky Flats to the Savannah River Site and Los Alamos National Laboratory. In this EIS, DOE considers that the implementation of mitigation measures would effectively prevent emissions of criteria air pollutants during facility modifications. Although new equipment may be added to existing facilities, no new facilities would be constructed for any of the technologies. DOE has also considered that no increase in criteria air pollutants emitted by vehicles driven by workers traveling to and from each site because the number of workers at each site would not change dramatically due to the implementation of any processes described in the EIS (see Section 4.18).

4.25.1 Cumulative Impacts at the Rocky Flats Environmental Technology Site

Aside from the continuation of existing operation and waste management activities at Rocky Flats, reasonably foreseeable future actions at Rocky Flats include the transfer of certain Nuclear Weapons Complex nonnuclear functions from Rocky Flats to other sites (DOE 1993a) and environmental restoration activities. **Tables 4–93** and **4–94** identify the ranges of cumulative impacts resulting from the management of the plutonium residues and scrub alloy addressed in this EIS, other future actions, and current activities. Future and ongoing cleanup actions include remediation of contaminated groundwater, solidification and disposition of solar pond sludge, and decontamination and decommissioning of facilities.

Table 4–93 Rocky Flats Cumulative Radiological Impacts

Impact Category	*Notes*	*Impacts of Existing Operations*	*Plutonium Residue and Scrub Alloy Impacts*			*Impacts of Other Reasonably Foreseeable Future Actions*[a]	*Cumulative Impacts*[b]		
			Min.	*Max.*	*Preferred*		*Min.*[c]	*Max.*[d]	*Preferred*
Waste Generation									
Stabilized Residues (drums)[e]		0	0	21,300	18,400	0	0	21,300	17,600

Impact Category	Notes	Impacts of Existing Operations	Plutonium Residue and Scrub Alloy Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Min.	Max.	Preferred		Min.[c]	Max.[d]	Preferred
Transuranic Waste (cubic meters)	1	6,300	400	8,200	500	4,900	11,600	19,400	11,700
Low-Level Waste (cubic meters)	1	41,000	900	12,100	900	96,000	138,000	149,000	138,000
Low-Level Mixed Waste (cubic meters)	1	21,000	0	0	0	192,000	213,000	213,000	213,000
Offsite Population									
Collective dose, 10 years (person-rem)	2	1.6	0.0046	0.024	0.0057	228	230	230	230
Number of latent cancer fatalities from collective dose	3	0.00080	2.3×10^{-6}	0.000012	2.9×10^{-6}	0.11	0.11	0.11	0.11
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	4	0.00047	0.00012	0.00105	0.00019	0.23	0.23	0.23	0.23
Probability of a latent cancer fatality	5	2.3×10^{-10}	6.0×10^{-11}	5.3×10^{-10}	9.5×10^{-11}	1.2×10^{-7}	1.2×10^{-7}	1.2×10^{-7}	1.2×10^{-7}
Worker Population									
Collective dose, 10 years (person-rem)	6	2,630	425	2,040	582	1,723	4,778	6,393	4,935
Number of latent cancer fatalities from collective dose	7	1.1	0.17	0.82	0.23	0.69	2.0	2.6	2.0

[a] Other reasonably foreseeable future actions include special nuclear materials management; deactivation, decontamination, and decommissioning of Rocky Flats facilities; and environmental restoration activities (DOE 1997).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats plutonium residues and scrub alloy, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 1.6-2 of the Waste Management Programmatic Environmental Impact Statement (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[e] Standard 55-gallon (208-liter) drums. (208 liters is equal to 0.208 cubic meters.) Most of these stabilized residues could be disposed of in WIPP as transuranic waste.

Notes:

(1) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) fromTables B.5-1, B.5-2, and B.5-3 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.

(2) Assumes all facilities operate concurrently for the same 10-year period. The dose due to existing operations is from Table 11.15-2 of DOE 1997c. The dose due to other reasonably foreseeable future actions is from Table 5.8-5 of DOE 1997, minus the dose due to existing operations.

(3) Assumes 0.0005 latent cancer fatalities per person-rem.

(4) Based on (DOE 1994e) for existing operations, which contains releases for the year 1992. The dose due to other reasonably foreseeable future actions is from Table 5.8-4 of DOE 1997.

(5) Assumes 5×10^{-7} latent cancer fatalities per mrem.

(6) Assumes that all facilities operate concurrently for the same 10-year period. The dose due to existing operations is based on the 1996 dose to workers of 263 person-rem (DOE 1997). The dose due to other reasonably foreseeable future actions is the sum of the doses in Table 5.8-1 of DOE 1997, minus the dose for residue management.

(7) Assumes 0.0004 latent cancer fatalities per person-rem.

Table 4–94 Cumulative Air Quality Impacts at Rocky Flats

Pollutant	Baseline Concentration ($\mu g/m^3$)	Modeled Concentration ($\mu g/m^3$)	Concentration from Other Onsite Sources[a] ($\mu g/m^3$)	Total Concentration ($\mu g/m^3$)	Averaging Time	Most Stringent Regulation or Guideline ($\mu g/m^3$)
Nitrogen Dioxide	1.4	0.00014	0.0	1.4	Annual	100
Hydrochloric Acid	0.0052	4.2×10^{-7}	0.001	0.0062	Annual	N/A
Carbon Tetrachloride	0.0024	0.000031	0.002	0.0044	Annual	N/A

N/A = not applicable

[a] Other approved onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at Rocky Flats, based on *Rocky Flats Cumulative Impacts Document*, (DOE 1997).

Wastes—As shown in Table 4-93, existing operations and other reasonably foreseeable future actions would not generate any stabilized residues, which have plutonium concentrations above the safeguards termination limits. The minimum amount of stabilized residues that could be generated under this EIS is also zero because for every material category there is at least one processing technology that would not generate any. Alternatives 1 and 4 would generate stabilized residues, while Alternatives 2 and 3 would not.

As shown in Table 4–93, existing operations and reasonably foreseeable future actions at Rocky Flats will generate approximately 11,200 m^3 (395,500 ft^3) of transuranic waste. The minimum and maximum amounts of transuranic waste to be generated from plutonium residues and scrub alloy are given in Table 4–80 in terms of numbers of drums. To compare the two, the numbers of drums from Table 4–80 were converted to cubic meters (4.8 drums per cubic meter), and then listed in Table 4–93. The maximum estimated volume of transuranic waste from plutonium residues and scrub alloy is 8,200 m^3 (293,000 ft^3), which would represent a major increase over the 11,200 m^3 (395,500 ft^3) from existing operations

As shown in Table 4–93, existing operations and reasonably forseeable future actions at Rocky Flats will generate approximately 137,000 m^3 (4,840,000 ft^3) of low-level waste. The minimum and maximum amounts of low-level waste to be generated from managing plutonium residues and scrub alloy are given in Table 4–80 in terms of numbers of drums. These values were converted to cubic meters and then listed in Table 4–93. The maximum estimated volume from plutonium residues and scrub alloy is 12,100 m^3 (430,000 ft^3), which would represent an increase of less than 10 percent of the 137,000 m^3 (4,840,000 ft^3) from existing operations and reasonably forseeable future actions.

Table 4–93 also shows that the largest volume of waste at Rocky Flats is low-level mixed waste. DOE has estimated that existing operations and reasonably forseeable actions will generate more than 200,000 m^3 (7,000,000 ft^3) of low-level mixed waste, while the processing of plutonium residues and scrub alloy is not expected to generate any low-level mixed waste.

Radiological Impacts—As identified in Table 4–93, the radioactive releases that would result from processing the Rocky Flats plutonium residues and scrub alloy would not noticeably increase the radiation dose or the associated number of latent cancer fatalities in the offsite population. In addition, the radiation dose to the maximally exposed offsite individual would remain well below the DOE regulatory limit of 10 mrem per year from atmospheric releases (DOE Order 5400.5). The radiation dose to the involved worker population could increase by as much as 78 percent of the dose from existing operations over the 10-year processing periods. However, doses to individual involved workers will be kept below the regulatory limit of 5,000 mrem per year (10 CFR Part 835). Furthermore, as low as reasonably achievable principles will be exercised to maintain individual worker doses below the DOE Administrative Control Level of 2,000 mrem per year (DOE 1994d). Each DOE site also maintains its own Administrative Control Level, but for the sake of consistency, DOE used the 2,000 mrem per year level throughout this EIS. Transportation workers (e.g., drivers) will be held to an annual limit of 100 mrem per year because they are not certified radiation workers. All worker doses are routinely monitored, and if any individual worker's dose approaches the annual limit, he or she would be rotated into another job.

Air Quality Impacts—The processing of plutonium residues and scrub alloy at Rocky Flats would involve potential releases of nitrogen oxide, carbon tetrachloride, and hydrochloric acid. The modeled offsite concentrations of these pollutants from Section 4.12 are presented in Table 4–94, along with the existing site concentrations (from Table 3–5) and concentrations from other onsite sources that would be operating at the same time as the plutonium residues and scrub alloy processing.

Because the total site concentrations are small compared to the standards or guidelines, the cumulative impacts of the proposed action, the existing site baseline, and other onsite sources should not be of concern with respect to these pollutants at Rocky Flats. Ambient air concentrations based on monitoring data and modeled data from nearby non-DOE sources are discussed in Section 3.1.3. If these ambient air concentrations are combined with the concentrations in Table 4–94, the resulting concentrations would be well below the air quality standards and guidelines. Note that combining the site's concentrations with the ambient concentrations is very conservative, as it is expected that the monitors would be impacted by Rocky Flats emission sources in addition to non-DOE sources.

Rocky Flats is in a nonattainment area where standards for concentrations of criteria air pollutants are exceeded for particulates, carbon monoxide, and ozone. Section 176c of the 1990 Clean Air Act as amended requires that all Federal actions conform with the applicable State Implementation Plan. EPA has implemented rules that establish the criteria and procedures governing the determination of conformity for all Federal actions in nonattainment and maintenance areas (40 CFR 93.153). Since Rocky Flats is located in a nonattainment area for particulates, carbon monoxide, and ozone, proposed actions at this site have been evaluated and it has been determined that the total direct and indirect emissions associated with the proposed actions are below the emissions level for which a conformity determination is required (See Section 4.12).

4.25.2 Cumulative Impacts at the Savannah River Site

Aside from the continuation of existing operations and the activities addressed in this EIS, reasonably foreseeable future actions at the Savannah River Site include continued management of spent nuclear fuels (DOE 1995e), tritium supply and recycling (DOE 1995a), processing of F-Canyon plutonium solutions to plutonium metal (DOE 1994a), interim management of nuclear materials (DOE 1995b), operation of the Defense Waste Processing Facility (DOE 1994c), other site projects for the management of waste (including environmental restoration activities) (DOE 1995d), storage and disposition of weapons-usable fissile materials (DOE 1996a), stockpile stewardship and management (DOE 1996b), and disposition of surplus highly enriched uranium (DOE 1996c).

Tables 4–95 and **4–96** identify the ranges of cumulative waste and radiological impacts resulting from these other actions, the processing of Rocky Flats plutonium residues and scrub alloy, and current activities that include atmospheric radiological releases from the Vogtle Nuclear Power Plant, located near the Savannah River Site. Table 4–95 includes the impacts of the Savannah River Site managing aluminum-clad spent nuclear fuel, as recently analyzed and decided by DOE (DOE 1995e).

Table 4–95 Savannah River Site Cumulative Radiological Impacts

Impact Category	*Notes*	*Impacts of Existing Operations*	*Plutonium Residue and Scrub Alloy Impacts*			*Impacts of Other Reasonably Foreseeable Future Actions*[a]	*Cumulative Impacts*[b]		
			Min.	*Max.*	*Preferred*		*Min.*[c]	*Max.*[d]	*Preferred*
Waste Generation									

Impact Category	Notes	Impacts of Existing Operations	Plutonium Residue and Scrub Alloy Impacts			Impacts of Other Reasonably Foreseeable Future Actions[a]	Cumulative Impacts[b]		
			Min.	Max.	Preferred		Min.[c]	Max.[d]	Preferred
High-Level Waste (canisters)[e]	1	4,600	0	43 [f]	5 [f]	(g)	4,600	4,643	~4,600
Transuranic Waste (cubic meters)	2	17,100	0	100	10	65,000	82,100	82,200	~82,100
Low-Level Waste (cubic meters)	3	500,000	0	200	42	2,500,000	3,000,000	3,000,000	3,000,000
Low-Level Mixed Waste (cubic meters)	4	13,000	0	0	0	11,000,000	11,000,000	11,000,000	11,000,000
Saltstone (cubic meters) [h]	5	627,000	0	2,500	500	(g)	627,000	630,000	628,000
Offsite Population									
Collective dose, 10 years (person-rem)	6	68	0	0.38	0.062	686	754	754	754
Number of latent cancer fatalities from collective dose	7	0.034	0	0.00019	0.000031	0.34	0.37	0.37	0.37
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	8	0.14	0	0.0034	0.00057	9.8	9.9	9.9	9.9
Probability of a latent cancer fatality	9	7.0×10^{-8}	0	1.7×10^{-9}	2.9×10^{-10}	4.9×10^{-6}	5.0×10^{-6}	5.0×10^{-6}	5.0×10^{-6}
Worker Population									
Collective dose, 10 years (person-rem)	6	8,400	0	469	76	8,309	16,700	17,200	16,800
Number of latent cancer fatalities from collective dose	10	3.4	0	0.19	0.030	3.3	6.7	6.9	6.7

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to defense waste processing (DOE 1994c); tritium supply and recycle (DOE 1995a); spent nuclear fuel management, including spent nuclear fuel from foreign research reactors (DOE 1995e); other site-specific waste management actions, including environmental restoration activities (DOE 1995d); F-Canyon (DOE 1994a); interim management of nuclear materials (DOE 1995b); storage and disposition of weapons-usable fissile materials (DOE 1996a); stockpile stewardship and management (DOE 1996b); and disposition of highly enriched uranium (DOE 1996c).

[b] Impacts of existing operations, combined impacts from processing Rocky Flats plutonium residues and scrub alloy, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 11.17-2 of the Waste Management Programmatic EIS (DOE 1997c).

[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats plutonium residues and scrub alloy.

[e] Each canister is 2 feet (61 cm) in diameter, 10 feet (300 cm) tall, and contains approximately 3,700 pounds (1,680 kg) of high-level waste glass.
[f] Material managed as high-level waste.
[g] The waste generation due to other reasonably foreseeable future actions (20 years) is included in the column of waste generation due to existing operations.
[h] Although saltstone is a low-level waste, it is managed independently from other low-level wastes.

Notes:
(1) Data for existing operations from Table 1.6-2 of DOE 1997c.
(2) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-3 of DOE 1997c.
(3) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-1 of DOE 1997c.
(4) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-2 of DOE 1997c.
(5) Data for existing operations from Table 5-5 of DOE 1994a.
(6) Assumes all facilities operate concurrently for the same 10-year period.
(7) Assumes 0.0005 latent cancer fatalities per person-rem.
(8) Based on (DOE 1994e) for existing operations, which contains releases for the year 1992. Cumulative impacts conservatively assume all facilities operate simultaneously and that the total radiological doses to the maximally exposed individual from processing residues and scrub alloy are received in 1 year.
(9) Assumes 5×10^{-7} latent cancer fatalities per mrem.
(10) Assumes 0.0004 latent cancer fatalities per person-rem.

Table 4–96 Estimated Maximum Radiological Doses and Resulting Health Effects to Offsite Population and Workers Due to Other Reasonably Foreseeable Future Actions at the Savannah River Site

Activity	Offsite Population		Offsite Maximally Exposed Individual		Worker Population	
	10-year Collective Dose (person-rem)	Latent Cancer Fatalities	Annual Dose (mrem)	Annual Fatal Cancer Risk	10-year Collective Dose (person-rem)	Latent Cancer Fatalities
Management of Spent Nuclear Fuels (DOE 1995e)	184	0.092	0.5	2.5×10^{-7}	760	0.30
Tritium Supply and Recycling (DOE 1995a)	85	0.043	4.1	1.2×10^{-6}	163	0.065
F-Canyon Plutonium Solutions (DOE 1994a)	1.2	0.00060	0.0027	1.4×0^{-9}	475	0.19
Interim Management of Nuclear Materials (DOE 1994c)	220	0.11	0.56	2.8×10^{-5}	1,405	0.56
Defense Waste Processing Facility (DOE 1994c)	0.71	0.00036	0.0011	5.5×10^{-10}	1,180	0.47
Other Site-Specific Waste Management, including Environmental Restoration (DOE 1995d)	150	0.075	0.36	1.8×10^{-7}	1,440	0.58
Storage and Disposition of Weapons-Usable Fissile Materials (DOE 1996a)	0.00018	9.0×10^{-8}	0.000014	7.0×10^{-12}	250	0.10
Stockpile Stewardship and Management (DOE 1996b)	8.6	0.0043	0.32	1.6×10^{-7}	1,560	0.62
Disposition of Surplus Highly Enriched Uranium (DOE 1995c)	36.6	0.018	3.96	2.0×10^{-6}	1,076	0.43
Total	686	0.34	9.8	4.9×10^{-6}	8,309	3.3

Wastes—As shown in Table 4–95, existing operations at the Savannah River Site will generate large volumes of high-level waste, transuranic waste, low-level waste, low-level mixed waste, and saltstone. Table 4–95 also lists the volumes of these wastes that could be generated from the processing of plutonium residues and scrub alloy. These values are from Table 4–84 and are converted from number of drums to cubic meters when necessary. The limited processing of plutonium residues and scrub alloy at the Savannah River Site would cause very small increases in the wastes to be managed at this site.

Radiological Impacts—As identified in Table 4–95, the radioactive releases that would result from processing the Rocky Flats plutonium residues and scrub alloy at the Savannah River Site would not noticeably increase the radiation dose or the associated number of latent fatal cancers in the offsite population. Even with the conservative assumptions in this analysis, the radiation dose to the maximally exposed offsite individual would remain below the DOE regulatory limit of 10 mrem per year discussed in Section 4.25.1. The radiation dose to the involved worker population could increase by about 3 percent of the dose from existing operations and other reasonably foreseeable future actions over the 10-year processing periods. Doses to individual involved workers would be maintained below the limits discussed in Section 4.25.1.

Air Quality Impacts—The processing of plutonium residues and scrub alloy at the Savannah River Site would involve potential releases of nitrogen oxide, nitric acid, hydrogen fluoride, and phosphoric acid. The modeled offsite concentrations of these pollutants from Section 4.12 are presented in **Table 4–97**, along with site baseline concentrations (from Table 3–14) and concentrations from other onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at the Savannah River Site.

Because the total site concentrations are lower than the applicable standards, the cumulative impacts of the proposed action, the existing site baseline, and other onsite sources, should not be of concern with respect to air quality at the Savannah River Site. Ambient air concentrations based on monitoring data are discussed in Section 3.2.3. If these ambient air concentrations are combined with the concentrations in Table 4–97, the resulting concentrations would be below the air quality standards and guidelines. Note that combining the site's concentrations with the ambient concentrations is very conservative, as it is expected that the monitors would be impacted by Savannah River emission sources as well as any non-DOE sources. In addition, the State air quality agency does not require the site to add monitored concentrations to modeled concentrations for demonstrating compliance with the air quality standards (Savannah River Site, 1998).

Table 4–97 Cumulative Air Quality Impacts at the Savannah River Site

Pollutant	***Baseline Concentration ($\mu g/m^3$)***	***Modeled Concentration ($\mu g/m^3$)***	***Concentration from Other Onsite Sources[a]***	***Total Concentration ($\mu g/m^3$)***	***Averaging Time***	***Most Stringent Regulation or Guideline ($\mu g/m^3$)[b]***
Nitrogen Dioxide	8.8	0.039	3.6	12.4	Annual	100
Nitric Acid	50.96	0.65	4.76	56.37	24-hour	125
Hydrogen Fluoride	0.09 0.39 1.04 1.99	0.00036 0.0032 0.0032 0.0051	0.019 0.067 0.175 0.327	0.11 0.46 1.22 2.32	30-day 7-day 24-hour 12-hour	0.8 1.6 2.9 3.7
Phosphoric Acid	0.462	0.0016	0.0	0.464	24-hour	25

[a] Other approved onsite sources which would be operating at the same time as the plutonium residues and scrub alloy processing at Savannah River based on the *Storage and Disposition of Weapons - Usable Fissile Materials Final PEIS*, (DOE 1996a).
[b] Federal and State standards.

4.25.3 Cumulative Impacts at Los Alamos National Laboratory

Aside from the continuation of existing operations and from the activities addressed in this EIS (limited to the processing of pyrochemical salt residues), reasonably foreseeable future actions at Los Alamos National Laboratory include construction and operation of the dual-axis hydrodynamic test facility (DOE 1995c), medical isotope production project (DOE 1996d), stockpile stewardship and management (DOE 1996b), and environmental restoration activities.

Wastes—As shown in **Table 4–98**, existing operations at Los Alamos National Laboratory will generate large volumes of transuranic waste, low-level waste, and low-level mixed waste. Table 4–98 also lists the volumes of these waste that could be generated from the processing of pyrochemical salts. These values are from Table 4–88 and are converted from number of drums to cubic meters when necessary. The limited processing of plutonium residues at Los Alamos National Laboratory would cause very small increases in the wastes to be managed at this site.

Table 4–98 Los Alamos National Laboratory Cumulative Radiological Impacts

Impact Category	*Notes*	*Impacts of Existing Operations*	*Plutonium Residue and Scrub Alloy Impacts*			*Impacts of Other Reasonably Foreseeable Future Actions*[a]	*Cumulative Impacts*[b]		
			Min.	*Max.*	*Preferred*		*Min.*[c]	*Max.*[d]	*Preferred*
Waste Generation									
Transuranic Waste (cubic meters)	1	10,800	0	600	200	4,400	15,200	15,800	15,400
Low-Level Waste (cubic meters)	2	150,000	0	1,300	400	325,000	475,000	476,000	475,000
Low-Level Mixed Waste (cubic meters)	3	2,770	0	0	0	980	3,750	3,750	3,750
Offsite Population									
Collective dose, 10 years (person-rem)	4	16	0	0.0024	0.00079	16.9	33	33	33
Number of latent cancer fatalities from collective dose	5	0.0079	0	1.2×10^{-6}	4.0×10^{-7}	0.0085	0.016	0.016	0.016
Offsite Maximally Exposed Individual									
Annual dose, atmospheric releases (mrem)	6	7.9	0	0.00080	0.00027	0.37	8.3	8.3	8.3
Probability of a latent cancer fatality	7	4.0×10^{-6}	0	4.0×10^{-10}	1.4×10^{-10}	1.9×10^{-7}	4.2×10^{-6}	4.2×10^{-6}	4.2×10^{-6}
Worker Population									
Collective dose, 10 years (person-rem)	4	4,580	0	160	8.8	763	5,340	5,340	5,350
Number of latent cancer fatalities from collective dose	8	1.8	0	0.064	0.0035	0.31	2.1	2.2	2.1

[a] Other reasonably foreseeable future actions include actions evaluated in EISs related to dual-axis radiographic hydrodynamic test facility (DOE 1995c), medical isotope production (DOE 1996d), and stockpile stewardship and management (DOE 1996b).
[b] Impacts of existing operations, combined impacts from processing Rocky Flats pyrochemical salts, and impacts of other reasonably foreseeable future actions. Existing operations include those associated with the preferred alternative for combined waste management as given in Table 11.9-2 of the Waste Management Programmatic Environmental Impact Statement (DOE 1997c).
[c] Cumulative impacts, including minimum combined impacts from processing Rocky Flats pyrochemical salts.
[d] Cumulative impacts, including maximum combined impacts from processing Rocky Flats pyrochemical salts.

Notes:
(1) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-3 of DOE 1997c.
(2) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-1 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.
(3) Data for existing operations from Table 1.6-2 of DOE 1997c. Data for other reasonably foreseeable future actions (20 years) from Table B.5-2 of DOE 1997c, not counting waste requiring Access Controls Only and/or No Further Action.
(4) Assumes all facilities operate concurrently for the same 10-year period.
(5) Assumes 0.0005 latent cancer fatalities per person-rem.
(6) Based on (DOE 1994e) for existing operations, which contains releases for the year 1992. Cumulative impacts conservatively assume all facilities operate simultaneously and that the total radiological doses to the maximally exposed individual from processing Rocky Flats pyrochemical salts are received in 1 year.
(7) Assumes 5×10^{-7} latent cancer fatalities per mrem.
(8) Assumes 0.0004 latent cancer fatalities per person-rem.

Radiological Impacts—As identified in Table 4–98, the radioactive releases that would result from processing the Rocky Flats pyrochemical salts at Los Alamos National Laboratory would cause very small increases in the radiation dose or the associated number of latent fatal cancers in the offsite population. The radiation dose to the maximally exposed offsite individual would remain below the DOE regulatory limit of 10 mrem per year as discussed in Section 4.2.5.1. The radiation dose to the involved worker population could increase by three percent of the dose from existing operations and other reasonably foreseeable future actions over the 10-year processing periods. Doses to individual involved workers would be maintained below the limits discussed in Section 4.25.1. **Table 4-99** shows the contributions to the cumulative impacts from specific reasonably foreseeable future actions.

Table 4–99 Estimated Maximum Radiological Doses and Resulting Health Effects to Offsite Population and Workers Due to Other Reasonably Foreseeable Future Actions at the Los Alamos National Laboratory

	Offsite Population		*Offsite Maximally Exposed Individual*		*Worker Population*	
Activity	*10-year Collective Dose (person-rem)*	*Latent Cancer Fatalities*	*Annual Dose (mrem)*	*Annual Fatal Cancer Risk*	*10-year Collective Dose (person-rem)*	*Latent Cancer Fatalities*
Dual-Axis Hydrodynamic Test Facility (DOE 1995c)	9.0	0.0045	0.02	1.0×10^{-8}	3.0	0.0012
Medical Isotope Production Project (DOE 1996d)	6.6	0.0033	0.15	7.5×10^{-8}	120	0.048
Stockpile Stewardship and Management (DOE 1996b)	1.3	0.00065	0.20	1.0×10^{-7}	640	0.26
Total	16.9	0.0085	0.37	1.9×10^{-7}	763	0.31

Air Quality Impacts—For the Los Alamos National Laboratory, the emissions of air pollutants from the processing of pyrochemical salts would be very small because only limited processing would take place at this site. In addition, the baseline concentrations of criteria air pollutants and hazardous air pollutants are much smaller than the applicable standards (see Table 3–21).

4.25.4 Cumulative Impacts of Intersite Transportation

The cumulative impacts from transportation of plutonium residues and scrub alloy from Rocky Flats to the Savannah River Site and Los Alamos National Laboratory are identified in Appendix E. Since likely transportation routes cross about nine States, cumulative impacts are computed on a national basis. Occupational radiation exposure to transportation workers and exposure to the public (from Section 4.24) would each increase by about 0.01 percent from the estimated cumulative exposure between 1943 and 2035 and would represent an estimated 0.1 percent of the cumulative exposure over the 10-year processing period. An additional traffic fatality is not expected (Section 4.24), and the incremental increase in traffic fatalities would be less than 0.0001 percent per year.

4.26 Relationship Between Short-Term Uses of the Environment and Long-Term Productivity

Implementation of any of the technologies for management of plutonium residues and scrub alloy currently stored at Rocky Flats would result in the short-term use of existing facilities and environmental resources. Facility modifications would be required for implementation of some of the offsite processing technologies such as mediated electrochemical oxidation at the Savannah River Site. However, none of the technologies would require the construction of new facilities. If offsite processing were selected for implementation, transportation of materials from Rocky Flats to any of the other candidate sites would occur on existing roadways. Estimates of the duration for the various alternatives range from less than 5 years to more than 20 years. Activities during that time would result in emissions to the atmosphere that would not measurably affect regional or global air quality. Although implementation of some of the processing technologies could impact the scheduled shut-down of Rocky Flats, short-term uses of the environment would have no appreciable beneficial or adverse effects on long-term productivity of the environment on, or in the vicinity of, any of the sites assessed in this EIS.

4.27 Irreversible and Irretrievable Commitment of Resources

All processing activities in this EIS would be conducted at existing facilities. Modifications to existing facilities would consist of improvements required to meet current environmental standards or the installation of new processing equipment. Materials required for the processing technologies, utilities, and fuel required for transportation options comprise the irretrievable resources required to implement the various options. Section 4.19 discusses these resources in detail. None of the alternatives require resources that would noticeably affect local or national supplies or that would noticeably affect the quality of the local or global environment.

4.28 Industrial Safety

The plutonium residues and scrub alloy would be processed at Rocky Flats, and additional processes may be performed at the Savannah River Site F-Canyon and F-B Line, the Savannah River Site H-Canyon and H-B Line, and the Los Alamos National Laboratory. Estimates of potential industry safety impacts to workers processing the residues and scrub alloy at these facilities were made using the average DOE occupational injury/illness and fatality rates shown in **Table 4-100** (DOE 1997g). The potential industrial safety impacts to the workers are presented in **Table 4-101**.

Table 4–100 Average Occupational Injury/Illness and Fatality Rates (per worker-year)

Category	*All Labor Categories (Process Operations)*	
	Total Injury/Illness	*Fatalities*
DOE and Contractors	0.032	0.000032
Private Industry	0.084	0.000097

Table 4–101 Industrial Safety Impacts from Processing Plutonium Residues and Scrub Alloy

Process Location	*Number of Injuries/Illnesses*	*Number of Fatalities*
Rocky Flats	12.5 to 77.0	0.013 to 0.077
Savannah River Site F-Canyon/F-B Line	0 to 14.1	0 to 0.014
Savannah River Site H-Canyon/H-B Line	0 to 32.8	0 to 0.033
Los Alamos National Laboratory	0 to 6.2	0 to 0.0062

4.29 References

ATSDR (Agency for Toxic Substances and Disease Registry), 1990, *Toxicological Profile for Plutonium*, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service, ATSDR/TP-90-21, Washington, DC, December.

De Planque, 1994, "Remarks by Dr. E. Gail de Planque, Commissioner, U.S. Nuclear Regulatory Commission before the NRC Workshop on Site Characterization for Decommissioning," No. S-28-94, Office of Public Affairs, Washington, DC, November 29.

DOE (U.S. Department of Energy), 1998a, *Draft Environmental Impact Statement for the Construction and Operation of a Tritium Extraction Facility at the Savannah River Site,* DOE/EIS-0271D, Savannah River Operations Office, Aiken, South Carolina, May.

DOE (U.S. Department of Energy), 1998b, Surplus Plutonium Disposition Draft Environmental Impact Statement, DOE/EIS-0283-O, Office of Fissile Materials Disposition, Washington, DC, July.

DOE (U.S. Department of Energy), 1998c, *Draft Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, NM, April.

DOE (U.S. Department of Energy), 1997, *Rocky Flats Cumulative Impacts Document*, Golden, CO., June 10.

DOE (U.S. Department of Energy), 1997b, *Annual Report of Waste Generation and Pollution Prevention Progress 1996*, Office of Pollution Prevention, Office of Environmental Management, Washington, DC, August.

DOE (U.S. Department of Energy), 1997c, *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-F, Office of Environmental Management, Washington, DC, May.

DOE (U.S. Department of Energy), 1997d, *Technical Standard for Worker Protection in Plutonium Facilities*, DOE Standard SAFT-0055, Draft, April.

DOE (U.S. Department of Energy), 1997e, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S, Carlsbad Area Office, Carlsbad, NM, September.

DOE (U.S. Department of Energy), 1996a, *Storage and Disposition of Weapons-Usable Fissile Materials, Final Environmental Impact Statement*, DOE/EIS-0229, December.

DOE (U.S. Department of Energy), 1996b, *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, DOE/EIS-0236, September.

DOE (U.S. Department of Energy), 1996c, *Disposition of Surplus Highly Enriched Uranium, Final Environmental Impact Statement*, DOE/EIS-0240, June.

DOE (U.S. Department of Energy), 1996d, *Medical Isotopes Production Project: Molybdenum-99 and Related Isotopes Environmental Impact Statement*, DOE/EIS-0249, Office of Nuclear Energy, Washington, DC, April.

DOE (U.S. Department of Energy), 1996e, Notice of Intent to prepare an Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site, *Federal Register*, Volume 61, p.58866, November 19.

DOE (U.S. Department of Energy), 1995a, *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling*, DOE/EIS-0161, Office of Weapons Complex Reconfiguration, Washington, DC, October.

DOE (U.S. Department of Energy), 1995b, *Final Environmental Impact Statement, Interim Management of Nuclear Materials, Savannah River Site, Aiken, South Carolina*, DOE/EIS-0220D, Savannah River Operations Office, Aiken, SC, October.

DOE (U.S. Department of Energy), 1995c, *Dual Axis Radiographic Hydrodynamic Test Facility, Final Environmental Impact Statement*, DOE/EIS-0228, Albuquerque Operations Office, Los Alamos Area Office, Albuquerque, NM, August.

DOE (U.S. Department of Energy), 1995d, *Savannah River Site Waste Management Final Environmental Impact Statement*, DOE/EIS-0217, Savannah River Operations Office, Aiken, SC, July.

DOE (U.S. Department of Energy), 1995e, *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement*, DOE/EIS-0203, Office of Environmental Management, Idaho Operations Office, Idaho Falls, ID, April.

DOE (U.S. Department of Energy), 1994a, *Final F-Canyon Plutonium Solutions Environmental Impact Statement*, DOE/EIS-0219, Savannah River Operations Office, Aiken, SC, December.

DOE (U.S. Department of Energy), 1994b, Memorandum for the Secretary, "Commitment to Prohibit the Use of Plutonium-239 and Highly Enriched Uranium Separated and/or Stabilized During Facility Phaseout, Shutdown, and Cleanout Activities for Nuclear Explosive Purposes," December 30, 1994.

DOE (U.S. Department of Energy), 1994c, *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility*, DOE/EIS-0082-S, Savannah River Operations Office, Aiken, SC, November.

DOE (U.S. Department of Energy), 1994d, *U.S. DOE Radiological Control Manual*, DOE/EH-0256T (Revision 1), Assistant Secretary for Environment, Safety and Health, Washington, DC, April.

DOE (U.S. Department of Energy), 1994e, *Summary of Radionuclide Air Emissions from Department of Energy Facilities for CY 1992*, DOE/EH-0360, Assistant Secretary for Environment, Safety, and Health, Office of Environmental Guidance, Washington, DC, February.

DOE (U.S. Department of Energy), 1993a, *Nonnuclear Consolidation Environmental Assessment*, DOE/EA-0792, Office of Defense Programs, Washington, DC, June.

DOE (U.S. Department of Energy), 1993b, *Transporting Radioactive Materials - Q & A to Your Questions*, DOE/EM-0097, Washington, DC, April.

EG&G (Edgerton, Germeshausen, and Grier), 1993, *Reference Computations of Public Dose and Cancer Risk from Airborne Releases of Plutonium*, Nuclear Safety Technical Report RFP-4910, Revision 0, EG&G Rocky Flats, December 23.

EPA (U.S. Environmental Protection Agency), 1995a, *Integrated Risk Information System (IRIS), Summary for Phosphoric Acid* (available at http://www.epa.gov/ngispgm3/iris./irisdat/0697.DAT or through Risk Information Hotline at (513) 659-7254).

EPA (U.S. Environmental Protection Agency), 1995b, *Integrated Risk Information System (IRIS)*, *Summary for Hydrogen Chloride* (available at http://www.epa.gov/ngispgm3/iris/irisdat/0396.DAT or through Risk Information Hotline at (513) 569-7254).

EPA (U.S. Environmental Protection Agency), 1993, *Federal Register*, Volume 58, No. 228 (FRL-4805-1), November 30.

EPA (U.S. Environmental Protection Agency), 1991a, *Integrated Risk Information System (IRIS) Summary for Carbon Tetrachloride* (available at http://www.epa.gov/ngispgm3/iris/irisdat/0020.DAT or through Risk Information Hotline at (513) 569-7254).

EPA (U.S. Environmental Protection Agency), 1991b, *Integrated Risk Information System (IRIS) Summary for Ammonia* (available at http://www.epa.gov/ngispgm2/iris/substance_list.html or through Risk Information Hotline at (513) 569-7254).

IAEA (International Atomic Energy Agency), 1992, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*, Technical Report Series No. 332, Vienna, Austria.

ICRP (International Commission on Radiological Protection), 1991, *Recommendations of the International Commission on Radiological Protection*, November.

KHC (Kaiser-Hill Company), 1997, *Basis for Interim Operation Building 371/374 Complex*, Rocky Flats Environmental Technology Site, January 27.

Lewis, Sr., R. J., 1991, *Hazardous Chemicals Desk Reference*, Van Nostrand Reinhold, New York.

NCRP (National Council on Radiation Protection and Measurements), 1995, *Principles and Application of Collective Doses in Radiation Protection*, NCRP Report No. 121, Bethesda, MD.

NNPP (Naval Nuclear Propulsion Program), 1993, *Occupational Radiation Exposure for U.S. Naval Nuclear Plants and Their Support Facilities*, Report NT-93-2, Washington, DC, February.

NRC (U.S. Nuclear Regulatory Commission), 1997, "Approval Record Model No. TRUPACT-II Package Certificate of Compliance No. 9218, Revision No. 8," February 20.

NRC (U.S. Nuclear Regulatory Commission), 1991, *Standards for Protection Against Radiation* (Revised) 10 CFR, Washington, DC, December.

Polycove, M., 1997, *The Rise and Fall of the Linear No-Threshold Theory of Radiation Carcinogenesis*, Nuclear New, Vol. 40, No. 7, pp. 34-37, June.

SAIC (Science Applications International Corporation), 1998, *Air Dispersion Modeling of the Emissions from the Processing of the Rocky Flats Residues and Scrub Alloy*, Germantown, MD, June.

Sax, N. I., and R. J. Lewis, Sr., 1987, *Hazardous Chemicals Desk Reference*, Van Nostrand Reinhold, New York.

Slovic, Paul, 1986, *Informing and Educating the Public About Risk*, Society for Risk Analysis, Vol. 6, No. 4, January 14.

SRS (Savannah River Site), 1998, Personnel Communications, Chuck Hunter (SRS), with Connie Haga (SAIC), "APT EIS Data Table Clarifications," May 13.